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ABBREVIATED TITLES USED IN THE ABSTRACTS

Abbreviated Title.	*Journal.*
Aircr. Engng	Aircraft Engineering.
Ann. Min. Belg.	Annales des Mines de Belgique.
Ann. Min. Roumanie	Annales des Mines de Roumanie.
Ann. Off. Combust. liq.	Annales de l'Office National des Combustibles Liquides.
Asph. u. Teer	Asphalt und Teer.
Auto. Engr	Automobile Engineer.
Auto. Tech. Z. (Berlin)	Automobiltechnische Zeitschrift (Berlin).
Azerb. neft. Khoz.	Azerbaidzhanskoe Neftyanoe Khozyaistvo.
Beitr. angew. Geophys.	Beitrage angewandte Geophysik.
Beitr. Geophys.	Beitrage zur Geophysik.
Bitumen	Bitumen.
Bohrtech. Z.	Bohrtechniker Zeitung.
Bol. Geol. y Min. (Caracas)	Boletin de Geologia y Mineria (Caracas).
Bol. Inform. Petroleras (B.A.)	Boletin de Informaciones Petroleras (Buenos Aires).
Boll. Soc. geol. ital.	Bolletin de la Societa Geologica Italiana.
Brennst Chemie	Brennstoff Chemie.
Bull. Acad. Sci. (U.S.S.R. Inst. Seismol.)	Bulletin of the Academy of Sciences (U.S.S.R. Institute of Seismology).
Bull. Amer. Ass. Petrol. Geol.	Bulletin of the American Association of Petroleum Geologists.
Bull. Amer. geol. Soc.	Bulletin of the American Geological Society.
Bull. Ass. franç. Tech. Pétrol.	Bulletin de l'Association Français des Techniciens du Pétrole.
Bull. Inst. Min. (metall.) Engrs	Bulletin of the American Institute of Mining and Metallurgical Engineers.
Bull. Math. Phys. Éc. polyt. Bucharest	Bulletin de Mathematique et de Physique, Bucharest (École-polytechnique).
Bull. roum. geol. Soc.	Bulletin of the Roumanian Geological Society.
Bull. seismol. Soc. Amer.	Bulletin of the Seismological Society of America.
Bull. Univ. Texas (Bur. econ. Geol. Techn.)	Bulletin of the University of Texas (Bureau of Economic Geology and Technology).
Bur. Stand. J. Res., Wash.	United States Bureau of Standards Journal of Research, Washington.
Calif. Oil World	California Oil World.
Canad. J. Res.	Canadian Journal of Research.
Canad. Min. J.	Canadian Mining Journal.
Canad. Min. metall. Bull.	Bulletin of the Canadian Institute of Mining and Metallurgy.
Chem. & Ind.	Chemistry and Industry.
Chem. Rev.	Chemical Reviews.
Chem. Tr. J.	Chemical Trade Journal.
Chem. Wkbld	Chemische Weekblad.
Chim. e Industria	La Chimica e l'Industria.
Chim. et Ind.	Chimie et Industrie.
C.R. Acad. Sci. (Paris)	Comptes Rendus hebdomadaires des Seances de l'Academie des Sciences (Paris).
C.R. Géol. Pétr. (Strasbourg)	Compte-Rendu des Seances du Groupe des Geologues Pétroliers de Strasbourg.
II^me Congrès Mond. Pétrole	II^me Congrès Mondial du Pétrole (Paris, 1937).
Diesel Eng. Us. Ass.	Diesel Engine Users Association.
Direccion Minas y Geol.	Publication of Direccion Minas y Geologicas (Argentine).
Econ. Geol.	Economic Geology.
Engineer	Engineer.
Engineering	Engineering.
E.P.	English Patent.
Fuel	Fuel in Science and Practice.
Gas Oil Pwr	Gas and Oil Power.
Geol. Mag. (Lond.)	Geological Magazine (London).
Geophys.	Geophysics.

Abbreviated Title.	*Journal.*
Glückauf	Glückauf.
Groz. Neft.	Groznenskii Neftyanik.
Industr. Engng Chem.	Industrial and Engineering Chemistry.
Industr. Engng Chem. Anal.	Industrial and Engineering Chemistry, Analytical Edition.
Industr. Pwr & Fuel Econ.	Industrial Power and The Fuel Economist.
Instruments	Instruments.
Int. Z. Bohrtech.	International Zeitschrift für Bohrtechnik.
J. Amer. chem. Soc.	Journal of the American Chemical Society.
J. appl. Chem. (U.S.S.R.)	Journal of Applied Chemistry, U.S.S.R.
J. appl. Phys.	Journal of Applied Physics.
J. chem., metall. min. Soc. S. Africa	Journal of the Chemical, Metallurgical and Mining Society of South Africa.
J. chem. Soc.	Journal of the Chemical Society.
J. Fuel Soc. Japan	Journal of the Fuel Society of Japan.
J. Geol.	Journal of Geology.
J. Inst. Fuel	Journal of the Institute of Fuel.
J. Instn auto. Engrs	Journal of the Institution of Automobile Engineers.
J. Inst. Petrol.	Journal of the Institute of Petroleum.
J. org. Chem.	Journal of Organic Chemistry.
J. phys. Chem.	Journal of Physical Chemistry.
J. R. aero. Soc.	Journal of the Royal Aeronautical Society.
J. Soc. aut. Engrs	Journal of the Society of Automotive Engineers.
J. Soc. chem. Ind.	Journal of the Society of Chemical Industry.
Khim. Tverd. Topliva	Khimiya Tverdovo Topliva.
Kop. Naft. Polsce	Kopalnictwo Naftowe w Polsce.
Matières grasses	Matières Grasses.
Min. & Metall.	Mining and Metallurgy.
Min. Mag. (Lond.)	Mining Magazine (London).
Monit. Pétr. roum.	Moniteur du Pétrole Roumain.
Montan. Rdsch.	Montanistische Rundschau.
Nat. Petrol. News	National Petroleum News.
Nature	Nature.
Neft. Khoz.	Neftyanoe Khozyaistvo.
Nickel Ind.	Nickel Industry.
Nov. Neft.	Novosti Neftepererabotki.
Nov. Tekhn. Bur.	Novosti Tekhniki Bureniya.
Nov. Tekhn. Neft.	Novosti Tekhniki Neftedobvicki.
Oel u. Kohle	Oel und Kohle vereinigt mit Erdoel und Teer.
Oil Gas J.	Oil and Gas Journal.
Oil Wkly	Oil Weekly.
Ole, Fette, Wachse	Ole, Fette, Wachse, Seife, Kosmetik.
Olii min.	Olii Minerali.
Paint Mnfr.	Paint Manufacture.
Paint Technol.	Paint Technology.
Petrol. Engr	Petroleum Engineer.
Petrol. Tech. (A.I.M.M.E.)	Petroleum Technology (American Institute of Mining and Metallurgical Engineers).
Petrol. Times	Petroleum Times.
Petrol. World (L.A.)	Petroleum World (Los Angeles).
Petrol. World (Lond.)	Petroleum World (London).
Petrol. Z.	Petroleum Zeitschrift.
Physics	Physics.
Pipe Line News	Pipe Line News.
Proc. Amer. Petrol. Inst.	Proceedings of the American Petroleum Institute.
Proc. Amer. Soc. Test. Mater.	Proceedings of the American Society for Testing Materials.
Proc. Ass. Asph. Pav. Technol.	Proceedings of the Association of Asphalt Paving Technologists.
Proc. Instn mech. Engrs	Proceedings of the Institution of Mechanical Engineers.
Proc. phys. Soc. (Lond.)	Proceedings of the Physical Society (London).
Proc. roy. Soc.	Proceedings of the Royal Society.
Przeg. Chem.	Przeglad Chemiczny.
Przem. Naft.	Przemysl Naftowy.
Quart. J. geol. Soc. Lond.	Quarterly Journal of the Geological Society of London.

Abbreviated Title.	*Journal.*
Rds & Rd Constr.	Roads and Road Construction.
Rec. Trav. chim. Pays-Bas	Receuil des Travaux Chimiques des Pays-Bas.
Refiner	Refiner and Natural Gasoline Manufacturer.
Rev. Comb. liq.	Revue des Combustibles Liquides.
Rev. Pétrolif.	La Revue Pétrolifère.
Rev. sci. Instrum.	Review of Scientific Instruments.
Riv. ital. Petrol.	La Rivista Italiana del Petroleo.
S. Afr. Min. (Engng) J.	South African Mining and Engineering Journal.
Strade	Strade.
Sulz. tech. Rev.	Sulzer Technical Review.
Summ. Ops, Calif. Oil Flds	Summary of Operations, Californian Oil Fields.
Tech. Phys. U.S.S.R.	Technical Physics of the U.S.S.R.
Tekn. Tidskr.	Teknisk Tidskrift.
Terr. Magn.	Terrestrial Magnetism.
Trans. Amer. geophys. Un.	Transactions of the American Geophysical Union.
Trans. Amer. Inst. Min. & Metall.	Transactions of the American Institute of Mining and Metallurgy.
Trans. Faraday Soc.	Transactions of the Faraday Society.
Trans. Inst. mar. Engrs	Transactions of the Institute of Marine Engineers.
Trans. Instn min. Engrs	Transactions of the Institution of Mining Engineers.
U.S. Bur. Mines, Inf. Circ.	United States Bureau of Mines, Information Circular.
U.S. Bur. Mines, Rep. Invest.	United States Bureau of Mines, Report of Investigations.
U.S. Bur. Mines, Tech. Paper	United States Bureau of Mines, Technical Paper.
U.S. Geol. Surv. Bull.	United States Geological Survey Bulletin.
U.S.P.	United States Patent.
World Petrol.	World Petroleum.
Z. dtsch. geol. Ges.	Zeitschrift der Deutschen Geologischen Gesellschaft.
Z. Geophys.	Zeitschrift für Geophysik.
Z. prakt. Geol.	Zeitschrift zur Praktische Geologie.
Z. ver. dtsch. Chem.	Zeitschrift Vereins deutscher Chemiker.

(Certain periodicals listed above have not been available during 1943).

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Geology and Development.

1. The Oil Industry in Alberta. A. W. Farmilo. *Canad. Min. J.*, January 1942, **63** (1), 17–27.—The author states in a preface that this paper is an attempt to study the oil industry in Alberta from two separate angles—namely, the geological and the economical—and to bring these two view-points together at the conclusion, by a speculation as to the future of the industry.

Oil areas in Alberta are divided into four major geological units, related to oil: the Rocky Mountain and Foothills region; the Alberta Geosyncline region; the Plains region; and the Southern Alberta border and Sweet-Grass Uplift Region.

The Rocky Mountain and Foothills Region embraces approximately 36,500 sq. miles, of which some 175 sq. miles have been proved to contain oil or gas. Turner Valley, the largest producing area of petroleum in Canada, falls within the foothill belt forming the eastern margin of the area. The Alberta Geosyncline region occupies

an area of some 66,000 sq. miles, but it has been estimated that oil and gas have only been produced from an area amounting to 500 sq. miles. The region extends from the International Boundary northwards to Lesser Slave Lake. It consists of a large basin derived as a result of thrust pressures from the Rocky Mountain Uplift to the west. Hitherto it has yielded little oil but considerable gas, although on 3rd January, 1941, a well situated at Steveville, on the eastern edge of the geosyncline, after being plugged back from 4250 ft. to 3325 ft. yielded a 25° A.P.I. sweet oil, flowing at the rate of 521 brls. per day.

The Great Plains Region extends for approximately 141,000 sq. miles, and includes all the area north and east of the Alberta Geosyncline. Depths to producing zones are not so great as in other parts of Alberta, and the several fields which have been developed have yielded a rather heavy oil from fairly thin sands.

The Southern Alberta border and Sweet-Grass Uplift Region falls into a different category by reason of its own particular structure, which is not related either to the Alberta Geosyncline or to the Plains Region. It includes the fields directly associated with the Sweet-Grass Uplift or Arch, and occupies an area of some 3000 sq. miles to the immediate north of the Southern Alberta Boundary. The region has had several small producers, but it would seem on all counts that it contains large gas accumulations rather than commercial quantities of oil.

Economically Alberta's greatest problem is not the need for wider markets, but the need for greater reserves and new oil-fields. Steveville is a step in the right direction, but whether or not it will be opened up as a new field is still undecided.

As regards future prospects, the author has several observations to make. There is lack of consolidated legislation, which is not conducive to efficiency in the industry. Greater exploration is required in new areas. Until Alberta's supplies are insured, self-sufficiency in the Dominion will not be achieved and imports will be necessary. Hope of wider markets is dependent on reduced transport rates on gasoline made from Turney Valley crude between Saskatchewan and Regina refineries and Winnipeg.

H. B. M.

2.* New Frontiers in Micropalæontology. With especial reference to Petroleum Exploration. C. Croneis. *Econ. Geol.*, January–February 1942, **37** (1), 16–38.—It is advocated in this paper that the micropalæontology of oil-field waters should be extensively re-examined; also that the oils themselves should be further exhaustively studied by microscopical methods. Methods conducive to increased speed and efficiency of separation of organic remains from crude oils are being evolved in the author's laboratories. The basis of this work is Sander's method ("The Microscopical Examination of Crude Petroleum," *J. Inst. Tech.*, 1937, **23**, 527–573). It is essential, though, that more efficient water-soluble filters be devised and that the gold size commonly employed to entrap the remains during centrifuging be improved or a substitute found. It may be that the key to the solution of the problem of oil origin will be found by means of such micropalæontological investigation of organic remains entombed in the oil.

In the past much work has been undertaken in an endeavour to establish the validity or increase the value of certain fossil groups as stratigraphic markers, also to increase the speed of stratigraphic diagnosis in petroleum geology. Experts have, however, now reached a position where it is possible to examine as many as 100 samples a day and to log from 3000 to 4000 ft. of section, using only a few "marker" foraminifera. Present bias of research is, therefore, less towards speed than towards discovery of new "markers."

The author discusses current trends of researches embracing foraminifera (fusilinids and arenaceous foraminifera), Early and Middle Palæozoic micropalæontology (radiolaria, scolecodonts and conodonts, bryozoa), echinoderm fragments and microscopic and semi-microscopic plants (diatoms, charophytes, flagellates, spores and pollen, algal dust).

In conclusion it is pointed out that however many new micropalæontological groups are discovered, their full academic and economic possibilities will never be realized until they are studied in their proper and complete ecological relationships. Emphasis must be given to this type of investigation, particularly now that the location of stratigraphical rather than structural traps for petroleum has assumed importance. Evolution of a suitable technique of investigation cannot be left to the

geologist alone: it must be referred to experts in the sciences of sedimentology, micromineralogy, and biology. H. B. M.

3. Development of Alberta Oil in 1941. J. L. Irwin. *Canad. Min. J.*, **63** (2), February, 1942, 99–103.—During 1941 the province of Alberta established a new record in oil production, the official figure being 9,908,643 brls. In addition 21,476 brls. of crude oil, gasoline, diesel, and burner oil were recovered from the McMurray tar-sands.

Statistics are given of monthly and yearly totals for the past four years, and totals for each of the years from 1914 to 1941. Production from the whole of Canada was well over 10 million brls. in 1941, and, as on previous occasions, Canada, of the seven oil-producing countries of the British Empire, took second place. There was, however, a difference of over 2 million brls. between Canada and Burma, which came third. Of total Canadian production in this year, Alberta contributed 98·08%, and Turney Valley field produced 99·22% of Alberta's total. As regards world crude-oil production for 1941, it is significant that the United States records an increase of nearly 60 million brls. Venezuela for the first time takes Russia's place as second largest producer, with an increase of nearly 41 million brls.

Alberta, as the principal oil-producing territory of Canada, has a great responsibility, and great achievements are expected. Among these are the continued lengthening of the Turner Valley field, increased production in other fields, discovery of new fields, and further developments in the McMurray tar-sand area. H. B. M.

4. Canadian Mineral Production. *Min. Mag.*, April 1942, **66** (4), 139. It is reported that in 1941 the value of fuels, including coal, natural gas, and crude petroleum, produced in Canada amounted to $83,363,000. In Alberta petroleum production advanced to a new peak in this year, and much exploratory work was carried out for new fields both in the plains and foothills. A number of new wells were drilled. H. B. M.

5.* Oil in Netherlands Indies. *Min. and Metall.*, July 1942, **23** (427), 395.—A report is given of the speech made before the New York Section A.I.M.E. by Mr. Kay, a member of the Secony-Vacuum Oil Co., on the petroleum situation in the Netherlands Indies.

Production of crude oil from the islands under Dutch control amounted to 160,000 brls./day before the Japanese invasion. Of this 12,000–15,000 brls. came from North Sumatra, 5000–7000 from Tarakan, North-east Borneo, 15,000–16,000 from Balik, Papan, South-east Borneo, and a small amount from Java. It is believed that the Japanese may be able to obtain a little oil from some of these areas by drilling new wells, most possibly at Tarakan, where the oil is shallow and of asphaltic base. Refineries were completely destroyed, so that it would be necessary to transport the crude oil to Japan for processing.

Mr. Kay gave some interesting information on the octane value of aviation gasoline used by the Japanese. Apparently the highest grade used is 87 octane, obtained by adding lead to regular grade gasoline. It is thought that Japanese planes may be equipped with supercharges to overcome the lower octane value. H. B. M.

6.* Oil Search in Western Australia. *Min. Mag.*, August 1942, **67** (2), 88.—The Freney Kimberley Oil Co. (1932), N.L., has suspended all drilling in the Kimberley district in the north-west of the State, where extensive exploratory work is in progress, pending receipt of new equipment from America. Instructions have since been given by the Government that drilling must cease in that part of the country which is situated inland from Broome, owing to danger of enemy action.

The total depth reached at the time of reporting is 4271 ft. H. B. M.

7.* The Problem of Petroleum Reserves in the United States. Part 2. J. H. McCammon. *Oil Wkly*, 21.9.42, **107** (3), 23.—Texas, Oklahoma, and California are the areas with the most favourable geological conditions for the accumulation of petroleum, and must therefore be depended on to offset the decline in reserves which will probably occur in other States.

Oklahoma has given 20% of the total U.S. production, and this has been provided by over 500 separate pools. Thirty-two of them have given over 25 million brl. each, eleven have given over 100 million brl., and one over 500 million brl. The discovery of large pools in Oklahoma has passed its peak, and it has been estimated that Oklahoma will yield only 5·3% of the future U.S. production. At the end of 1941 the State's reserves were 1,035,820,000 brl. The main structural features are well known, and were thoroughly tested a decade ago. The Nemaha Granite Ridge of Kansas in passing into Oklahoma gives rise to a series of en echelon ridges with anticlines on which lie fields such as Garber, Tonkawa, and Oklahoma City. To the north and east are prolific Bartlesville sandfields, mainly of the stratigraphic type. Only in the southern part of the State are there sizeable areas where drilling has not gone to the base of the productive column. Gas has been found on structures in the McAlester basin, where the Pennsylvanian is very thick. Since 1917 no field of over 40 million brl. has been found in the area of the Red River Uplift. Deep tests on geophysically located structures in the Anadarko–Ardmore basin have mostly been disappointing. In this basin the Ordovician will be very deep, and the strong compression involved in the folding has given low porosity in the shallow fields.

California has provided 23% of the U.S. total, and it may yield 16·5% of the future production. Four isolated districts in Southern California are responsible for the oil, and each of them has been known since before 1900. The relatively recent geophysical discoveries of deeply buried structures in the San Joaquin Valley are insignificant, from the point of view of production, compared with the superficially expressed anticlinal folds. The downward trend of reserves in California seems likely to continue. Vertically the Tertiary oil-bearing column has been thoroughly explored; the Cretaceous below has given only a little oil and some gas. The most promising possibility seems to be the discovery of other structural stratigraphic traps.

The likelihood of the discovery of many major fields of the pinch-out type appears remote, and even though some will be found, it is doubtful whether they can greatly alter the character of the reserve curve. Thus it appears that the U.S. reserves will decline in terms of demand, and also in terms of gross volume. G. D. H.

8.* Trenton Enhances Illinois Discovery Prospect. K. A. Spitznagel, *Oil Wkly*, 21.9.42, **107** (3), 41.—Most of the production from the Illinois Basin is from the McClosky limestone, the porosity of which is very variable and seems to be erratically related to structure. Production from this limestone declines rapidly. The Chester sand discoveries have been declining in the past year. The average daily production in the week ended 22nd August, 1942, was 274,000 brl., a rise of 19,700 brl./day over the average for the previous week. Most of this increase was undoubtedly due to the St. Jacobs field and to the new discovery at Covington, where large McClosky wells are being developed. The gross Illinois production in the first seven months of 1942 was 66,420,000 brl., compared with 71,808,000 brl. in the same period of 1941.

The St. Jacobs pool was opened in May 1942, in a porous zone 24 ft. below the top of the Trenton, at a depth of 2343 ft. Ten producers have been completed, and three dry holes. The average initial production was 450 brl./day after acid treatment. The field may cover 2600 acres, with 45 ft. of closure above the water-table.

Trenton production is also found at Dupo, Waterloo, Centralia, Salem, Westfield, and Martinsville. The first two are on the extreme western rim of the basin; St. Jacobs lies to the east; Centralia and Salem are still farther east on the west flank of the basin; and the other two fields are on the eastern flank of the basin. No commercial Trenton production has been found in the lower part of the basin.

The Dupo field has yielded about 3000 brl. of oil/acre, and may ultimately yield 4000 brl./acre. It is possible that St. Jacob may exceed this figure.

A good, thick porous section of Trenton extends from the southern boundary of Macoupin County to the southern boundary of Randolph County, with its western margin probably defined by faulting or a deep syncline near the Mississippi. Structures outside this porous zone have failed to give production.

St. Jacobs was located by seismic work.

Quite a lot of sub-surface data are available to indicate structural conditions in western Illinois, and these, used in conjunction with knowledge of the characteristics of the producing horizons, should facilitate the location of some major oil reserves in the central, eastern, and southern parts of the basin. G. D. H.

9. Texas Oil. G. B. Barbour. *Geog. J.*, October 1942, Vol. C. (4), 145–155.—Some remarkable summarized statistics on Texas oil are given in this paper. In 1941 new wells were drilled in this State at the rate of 870 a month. The average depth (3627 ft.) of these wells was over two-thirds of a mile, and the aggregate footage drilled in that year amounted to nine-tenths the diameter of the earth. Even after allowing for dry holes (practically every fourth borehole) and those producing gas instead of oil (1 in 37), there were 7652 new wells producing oil by the end of the year. Texan production was thus raised to the enormous total of 7,087,198,000 brl.

In 1901 Captain Lucas, a retired Austrian Army officer, obtained a production of 25,000 brl./day from a well drilled on a hillock marking the site of a buried salt-dome near Beaumont. This proof of Lucas' salt-dome theory did much to stimulate drilling activity, and within 2½ years production reached 20 million brl., while the price fell to an all-time low level of 5 cents./brl.

Throughout the State underground structural features vary considerably, and each is studied with extreme care to discover clues for further prospecting. The most common structural type likely to trap oil is an elongated dome or anticline formed where strata have been warped by crustal pressures. Other traps may develop round the margin of salt plugs the upward thrust of which has gradually pushed up clay-capped layers of sand. The importance of such traps was first realized as a result of Lucas' famous discovery.

Some two years ago the author spent several days in the oilfields of the San Antonio and Corpus Christi regions of South Texas, in company with Professor Robert H. Cuyler, of the University of Texas, who was responsible for the discovery of many of the producing fields. Descriptions are given of each of these districts which illustrate not only various modes of occurrence of oil, but equally many features common to other fields both in the methods of oil recovery and subsequent handling of it.

Formations in South Texas dip seawards. Thus as the coast is approached wells must be drilled deeper to strike the same horizons. The base of the Catahoula formation which caps the Frio deposits actually outcrops at the surface 70 miles inland, but is 5000 ft. below ground at the coast. In the Saxet field, 5 miles west of Corpus Christi, the Frio deposits yield oil from depths of 9900 ft. To take care of drilling to such depths, new and improved technical methods are constantly being devised. One of the special hazards is due to the enormous pressure generated in some of these fields. Special precautions have to be taken to prevent the escaping oil from blowing out the whole of the equipment and thus letting the well get out of control.

Reserves of Texas crude oil still in the ground, and therefore ultimately available, according to the 1942 estimate, exceed 10,623,516,000 brl., or nearly 56% of the whole reserve of the U.S. In December 1941 the "net daily allowable" in Texas was 1,555,192 brl., but following the declaration of war by the U.S. this was increased in 1942 by 65,467 brl. per day.

By Midsummer 1942 the volume of rail-transported oil in tank cars had risen to 700,000 brl./day, and Congress then decided to act on proposals to co-ordinate and extend the pipe-line service to Atlantic Coast ports. The scheme included a $35-million pipe-line from Long View in North-east Texas, across Arkansas to Salem in Southern Illinois, a route of 550 miles, scheduled to be laid in five months. Ten motor-driven pumps designed to transmit 300,000 brl./day were installed at 55-mile intervals. It takes two weeks to fill the 24-in. pipe, since 3½ million brl. must go in at the Texas terminal before any oil can be delivered at the other end. H. B. M.

10.* Development and Exploration Active in Argentina. W. A. Sawdon. *Petrol. Engr*, October 1942, **14** (1), 119.—Argentina produced 22,015,658 brl. of oil in 1941, 6·8% more than in 1940. Even this was only 63% of the country's requirements. Shipping has limited oil imports, and also restricted the acquisition of equipment.

70% of the 1941 output came from Comodoro Rivadavia, where the production rose by 740,529 brl. as a result of further development and the addition of the El Tordillo field. The Plaza Huincul output fell in 1941. The area containing the Tartagal, San Pedro, Aguas Blancas, and Rio Pescado fields had its maximum production in 1934, but extension to the fields caused the 1941 output to exceed that of 1940. The Mendoza production began in 1926, but approached the million-barrel per year mark only after the discovery of the deep zone at Tupungato in 1939. The Lulunta–Barrancas area has 8000-ft. wells, the deepest in Argentina.

Wildcatting has taken place in Patagonia during the past few years. Wells in Chubut were unsuccessful. 125 ml. west of Santa Cruz a large gas-flow was found below 2600 ft. Several shows were noted in a well near Zapala, south-west of Plaza Huincul, and 10 ml. west of Plaza Huincul a well had an initial production of 140 brl./day, but its high gas/oil ratio caused it to be closed in. Farther to the north-west, and 20 ml. from Plaza Huincul, a well drilled to 3600 ft. found three good gas-sands. This structure was located geophysically. 15 ml. south-east of Plaza Huincul a 1000-brl. well was brought in at a depth of 3270 ft. A test on the Carrizal structure found no oil in the lower horizons, but had oil-showings in the upper formations.

2 ml. north-west of the centre of the Tupungato structure the discovery well of the Refugio structure came in at 100 brl./day from the same producing horizon as at Tupungato. Dry gas and numerous oil-showings have been encountered on the Pampa Palauco structure of South Mendoza. 22,000,000 cu. ft. of gas/day and a little very heavy oil were produced. G. D. H.

11.* Geophysical Exploration in Brazil. W. A. Sawdon. *Petrol. Engr*, October 1942, **14** (1), 122.—Four areas of Brazil have oil-producing prospects, but drilling is largely confined to the most easily accessible region, which extends through coastal Bahia, Sergipe, and Alagoas. Oil production has been found near Bahia. Much of Brazil has been geologically surveyed, and in recent years geophysical work has been carried out where the oil prospects seemed most favourable. The drilling around Bahia and Maceio was based on geophysical surveys.

South and west of Sao Paulo is the Parana synclinal basin, which, while not so accessible as the Bahia–Alagoas area, will probably be explored in the near future. A number of unsuccessful wells have been drilled in the past forty years.

The Para area south of the Amazon delta appears to have petroleum possibilities. The Acre area is near the Peruvian border, relatively close to the Aguas Calientes field of Peru. There are oil-seeps in Peru near this last area. Accessibility is difficult, particularly in regions which are not close to the Amazon or its tributaries. Considerable geological and geophysical work will have to be carried out. G. D. H.

12.* Oil from the Garden of Eden. W. F. Foran. *Petrol. Engr*, October 1942, **14** (1), 85.—About 6000 B.C. there were flourishing lime, plaster, asphalt, salt, and ship-building industries near Hit, and boats were used to carry the materials from Hit to Ur. Ur and other places were destroyed by extensive floods, and later the city of Kish was built with bitumen and lime mortar, some 190 miles upstream from the site of Ur. Large quantities of asphalt were mined at Hit, and oil was recovered for use in lamps. Oil-seepages were also cultivated at Persepolis near the site of the present Anglo-Iranian oilfields, and at Nineveh in the Kirkuk region. After many vicissitudes the ancient oil industry declined, and was almost forgotten for a long period, until it was revived in the twentieth century. G. D. H.

13.* Petroleum Development in Canada. Part I. F. K. Beach. *Petrol. Engr*, October 1942, **14** (1), 128.—The first oil-well in Canada was drilled in 1858, and obtained oil from a gravel. In 1861 a gusher came in at a depth of 160 ft. in Ontario. The Ontario production rose to a maximum of 800,000 brl. in 1895, when there were 8000 producing wells, declined to 475,000 brl. in 1903, and had a second sharp peak of nearly 800,000 brl. in 1907.

The New Brunswick production was 22,000 brl. in 1942. Exploratory work has been carried out preparatory to further exploratory drilling.

Oil was discovered near Fort Norman in 1920. The two successful wells there have been pumped for about four months each year, giving 15,000–30,000 brl./year, and the oil has been cracked in a small plant to provide aviation gasoline. The reservoir rock appears to be a shale. Drilling on the coastal plain of British Columbia has not yet revealed oil production, but in the strip of sediments in the east of the province oil-showings have been found in the Flathead Valley.

Natural gas has been found at widely scattered points in Saskatchewan and Manitoba. A well in South-west Saskatchewan has penetrated 4000 ft. of post-Palæozoic sediments. These thin to the north and east, and disappear in Central Manitoba. The Cretaceous has not been thoroughly tested, and only a few wells have been drilled to the Palæozoic.

In the geosyncline east of Turner Valley there are about 9000 ft. of relatively flat post-Palæozoic beds, which rise and thin to the east for about 100 ml., and then show a dip to the east. The general trend is disturbed by the Sweetgrass Arch, the effects of which extend 60 ml. north of the U.S. border. Oil and gas occur on terraces on this structure, chiefly in U.S.A. Oil is found at Red Coulee, Skiff, and Taber, and gas at Foremost and Bow Island. The Lower Cretaceous continental beds show little evidence of structure, but oil has been found at numerous points, including Wainwright, Vermilion, Dina, and Athabaska. Other discoveries have been made at or near the top of the Palæozoic at Princess and Tilley. G. D. H.

14.* Production of Oil in the World To-day. W. A. Sawdon. *Petrol. Engr*, October 1942, **14** (1), 67–70.—Although the fields of the East Indies were put out of action before the Japanese occupation, it is possible that the Japanese may have built up supplies of drilling equipment beforehand, and so may have been able to rehabilitate some of the fields more quickly than was expected. It is also possible that skimming plants may have been erected. It is less likely that they will have been quite so anxious to put the Burma wells into commission again. The Punjab oil is safe from attack at present, but the Digboi production could easily be denied to the Allies by the cutting of the railroad over which the production is transported.

The fields of Iraq, Iran, Arabia, Bahrein Island, and Egypt gave 4·4% of the world's output last year, and they have a much greater potential. If Germany gets the Baku oil there may be a battle for the Near East oil. Exclusive of Sakhalin Island, Russia obtained 239 million brl. of oil last year, 72% of which came from the Baku area. Only 16% came from areas outside the Caucasian region. The Ural–Volga area provided 11·5%. The Kuban–Maikop fields have been thoroughly put out of action, and even if the Grozny fields are also lost, Russia's oil supplies will not be seriously reduced, while Germany will not be able to meet her own demands. The loss of all the Caucasian fields would not necessarily put Russia out of the war, since she has large stores of oil in addition to the Ural–Volga production. It is believed that the European production is still declining.

In Venezuela the 1941 production reached the peak of 224 million brl., but the submarine menace has curtailed output this year. Argentina gave 22 million brl. of oil in 1941, while Trinidad's output was 21 million brl. Colombia's output declined a little to 25,600,000 brl., Peru's output fell to 12 million brl., and that of Ecuador to 1½ million brl. The Mexican output was less than 43 million brl., a further decline, but Canada had a slight rise to over 10 million brl. U.S.A. provided 63·1% of the world's output. G. D. H.

15.* Venezuela Marks Time. W. A. Sawdon. *Petrol. Engr*, October 1942, **14** (1), 102.—The inability of Venezuela to ship oil and its products to Britain and U.S. has restricted the oil output, after a peak production had been attained in 1941. However, geological and geophysical prospecting have not been as seriously curtailed as the production and refining activity.

Oil was first produced commercially in Venezuela in 1917, and a sharp rise in output began in 1924, giving a peak about 1930, and, after a decline, further peaks in 1939 and 1941. Venezuela seems likely to have good marketing prospects after the war. Europe, Brazil, and other Atlantic coast South American countries are probable markets in addition to U.S.A.

The Lake fields provide 62% of the Venezuelan output. In the early part of 1942 the production was about 700,000 brl./day, but a decline set in in March, and the production is now about 400,000 brl./day.

Oil transport is one of the major problems to be considered in developing the interior part of Eastern Venezuela. In 1938 a pipe-line was laid from Temblador to a branch stream in the Orinoco delta. In 1939 a 16-in. line from Oficina to the Caribbean was completed, and later connections to this line were made from Leona, Santa Rosa, El Roble, Santa Ana, and San Joaquin. The Jusepin field had a pipeline connection to Quirequire.

Most of the producing wells are 2000–5000 ft. deep, but at Oficina there are 7000-ft. wells, and at El Roble and Santa Ana wells which are 8000–10,000 ft. deep.

A table gives the average daily production during 1940 and 1941, together with the types of producing wells in action on 31st December, 1941. G. D. H.

16.* Increased Rate of Completing Wells. Anon. *Oil Wkly*, 12.10.42, **107** (6), 33.—The average of 61·5 completions per day during the four weeks ended 26th September was about 10% above the completion rate of 55·4 per day for August, and also higher than the 59·5 per day for July. The September figures were the highest since February. Increased rates of completing wells were recorded in September in Arkansas, California, Colorado, Illinois, Indiana, Kansas, Kentucky, Mississippi, Ohio, Pennsylvania, West Virginia, and Wyoming. The relaxation of spacing regulations in Illinois was responsible for a considerable increase in completions in that state.

Tables show by States the drilling activity on 1st October, 1941, 1st September, 1942, and 1st October, 1942, and the state of the rigs; the numbers of completions in September 1941, August 1942, and September 1942, as well as the types of completion in September 1942 and the cumulative completions during the first nine months of 1942. G. D. H.

17.* Typical Oilfield Structures: Truncated Shore Line; East Texas Field, Texas. Anon. *Oil Gas J.*, 15.10.42, **41** (23), 48B.—The East Texas basin was originally continuous with the Mississippi river embayment, and bordered the folded Palæozoic continent formed by the uplift of the Appalachians and the Ouachitas. At different times during the Mesozoic, a large area within the basin was uplifted to give the Sabine Uplift, which subdivided the basin, while leaving a connecting channel north of the uplift. Beds pinched out on the flanks of the uplift. In East Texas the Lower Cretaceous sea extended right across the uplift, and at the end of the period it retreated to a point west of the East Texas field. As the sea again advanced the Woodbine sand was deposited. Possibly following this, and certainly following the deposition of the overlying Eagleford shales, the sea retreated, and the sand was eroded in parts of the field area and wholly in the area to the east. Later readvance of the sea deposited the Austin Chalk and younger beds.

The Woodbine sand is the only oil reservoir in the area. It is largely non-marine, with silts, ashes, and conglomerates. Much of it may be re-worked detritus on the old land surface. The reservoir is made up of many overlapping lenses. The oil may have migrated into its present position from deeper in the basin, or, alternatively, the oil-forming materials may have entered the Woodbine in its second submergence.

There are many other wedge-edge fields formed near the shore-lines of advancing seas. This type of sand is the basis of the numerous trend-plays of the Gulf Coastal area, the San Joaquin and Los Angeles basins, and Eastern Kansas and Oklahoma. Surface geological methods are of little use in locating these traps, but convergence studies and the reflection seismograph are helpful. G. D. M.

18.* Completions at Third Quarter Remain at 50 per cent. of Last Year. Anon. *Oil Gas J.*, 22.10.42, **41** (24), 97.—September, a five-week month, had 196 more well completions than August. The number of wells actively drilling was forty-three more than in August. The September completions numbered 1542, compared with 3073 in September 1941. In the first quarter of 1942 the completions were 30% below the 1941 figures, and by June the drop was 40%. Since August the drop has increased to 50% below the previous year's figures for the same period.

A table gives the number of completions, footage, types of completions, and the numbers of completions in different depth ranges, for September 1942. G. D. H.

19.* Wyoming Discovery Directs Attention to the Lakota Sand. T. R. Ingram. *Oil Gas J.*, 29.10.42, **41** (25), 25.—An oil discovery has been made in the wildcat on the Horse Creek structure of South-eastern Wyoming. The well is 24 ml. north-west of Cheyenne. It logged the top of the Dakota at 5265 ft., and oil-saturated cores were recovered from 5270–5290 ft. The Lakota lay at 5451–5489 ft. A drill-steam test at 5490 ft. gave 27 brl. of oil in thirty minutes. The total depth was 5531 ft., with some 58 ft. of Lakota sand. A packer was set at 5490 ft., and oil was obtained at the rate of 15 brl./hr. from the lower 24 ft. of the sand.

A major pool seems to have been located, and the discovery is also of areal significance. It is on the north-west rim of the Denver (Julesburg) basin, which is outlined by the Hartville, Cambridge, Sierra Grande, and Apishipa Arches, and the front mountain ranges. All the earlier fields but one were on domal structures near the

front mountain ranges. The exception is Greasewood, out in the basin, the discovery of which was followed by an extensive search for the Dakota, during which several wildcats had good shows of oil and one had much gas, although no fields were developed. Later the Pennsylvanian and older beds were sought, with tests based on seismic surveys. This work indicated favourable prospects.

Horse Creek is in a line with the fields on the western rim of the Denver basin in Colorado, and will revive interest in the prospects of the Dakota–Lakota of the adjoining counties. The structure was located by aerial photography, and then by surface geological and seismic work. G. D. H.

20.* **Dakota Activity Centres around Black Hills.** Anon. *Oil Gas J.*, 5.11.42, **41** (26), 60.—Four wells are being drilled in the Black Hills area of South Dakota, while there are four seismograph parties at work, three in North Dakota and one in South Dakota. A well in Oliver County, North Dakota, was abandoned as a dry hole in September, having entered the pre-Cambrian at 8831 ft. In South Dakota a well on the Flint Hill structure of the Chilson anticline is temporarily suspended in the Minnelusa sand at a depth of 2335 ft. It is the same section as one drilled in 1925, which reported oil-showings at 2085 ft. A second well is being drilled in Fall River County on Hat Creek. The two other wells are near Rapid City, north of the Fall River County locations. The well on the Black Gap structure reported a gas showing at 300 ft.

About 7 million acres are under gas or oil lease in the Dakotas.

Several deep water wells have been watched with interest. One showed oil in the Leo sand at the Black Hills Ordnance Depot in Fall River County. A number of natural gas wells occur in the Pierre area.

A well south of Baker, Montana, near the Dakota boundary, had oil shows at 6815–6825 ft., 8320–8350 ft., 8455–8500 ft., and 8644–8659 ft. Acidization was applied, and the well gave 707 brl. of liquid (77% oil) in four days, but was later abandoned. G. D. H.

21.* **Exploration in South Texas Needs Strong Stimulation.** W. V. Howard. *Oil Gas J.*, 5.11.42, **41** (26), 20.—Wildcatting in the coastal area of Texas and Louisiana in the third quarter of 1942 was 40% below the average quarterly level for 1941. Oil prices and legislation are said to have been largely responsible for this state of affairs. Last year 13·2% of the wildcats were successful in finding either oil or gas, but this year there have been only 8·1% of successful wildcats. There is a relationship between discoveries and new tests.

South Texas has not adequate reserves to tide it over a period of slackened exploration, for while there are large fields, most of the fields in this sector are approaching the stripper stage. South Central Texas is in an even worse position in this respect.

Coastal Louisiana has large probable, though undeveloped, reserves, but the deep drilling required to locate them is not attractive at present.

Tables compare the wildcatting in 1941 and 1942, and give the numbers of wildcats and discoveries by districts for the Upper and Lower Gulf Coast, and South and South Central Texas. G. D. H.

Drilling.

22.* **California Deep-Drilling Rig Uses Direct Electric Current.** L. D. Banderob and P. L. Savage. *Oil Gas J.*, 8.10.42, **41** (22), 45. The equipment is unique for several reasons. It is the highest-powered electric drive so far built for rotary drilling. It is the only existing direct-current drilling equipment using alternating-current power supply, as the direct-current generators for such a drive are usually driven by internal-combustion engines. The arrangement of the electrical equipment, especially the direct-current power supply and the portable substation, offers the maximum in portability; and once the equipment is in place, electrical connections are a matter of minutes.

A conventional type draw-works is driven by two direct-current drilling motors each rated 250 h.p. These two motors are capable of delivering considerably in excess of 800 h.p. for hoisting operations. Since the motors may be required to run

at very low speed for long periods during the drilling operation, ventilation is supplied to them by a blower, which takes air from a remote point to insure against the presence of explosive gases. Provision is made in the control scheme so that the ventilating fan is started a short time before applying power to the motors, in order that all explosive gas will be purged from the ventilating system. The two draw-works motors are connected to a twin gear, which is chain-connected to the draw-works jack-shaft. There are two motor-generator sets, each mounted on a self-supporting skid base. Each set is complete in itself and consists of a 350-h.p. induction motor, driving a 200-kw. direct-current generator. Each set also includes a direct-connected exciter rated 15 kw. at 125 volts. Either exciter is capable of providing all excitation required.

The first well, being exploratory, was subjected to considerable testing, involving many and frequent trips in and out of the hole under varying conditions, which afforded experience with the drilling motors comparable to drilling several deep wells. This experience provided an excellent opportunity to gauge the performance of this new equipment, the following being apparent: (1) The flexibility equals that of the finest steam equipment. (2) The ease and smoothness of control exceed that of any other equipment of the authors' experience, either steam, gas engine, or alternating-current electric. (3) The torque limiting feature inherent in this equipment is of great value in hoisting through tight places, through keyways in the hole, when rotating in difficult drilling, or when fishing. This feature provides at all times a cushion beyond which it is impossible to load the driven equipment. (4) The motor speed increases automatically as the load becomes lighter to a maximum of 1270 r.p.m. with an empty hook, which is ample. Therefore each stand of pipe is hoisted at a higher speed than the preceding stand. In effect, this is comparable to a mechanical drive with an infinite number of gear ratios and with each correct gear ratio automatically selected. (5) The performance of the electric equipment does not decline with continued hard use. A. H. N.

23.* Graphical and Mechanical Determination of the True Dip from Magnetically Orientatable Cores taken in Crooked Holes. G. D. Hobson. *J. Inst. Petrol.*, November 1942, **28** (227), 274–280.—A practical means for obtaining the true dip from cores with relative ease and in a short time is described in detail. The apparatus is simple to construct and use. A. H. N.

Production.

24. Calculation of Productivity Factors for Oil–Gas–Water Systems in the Steady State. H. H. Evinger and M. Muskat. *Petrol. Tech.*, January 1942, **5** (1), A.I.M.M.E. Tech. Pub. No. 1416, 1–10.—A method of calculating productivity factors for oil, gas, and water systems in the steady state in presented as an illustration of the quantitative application of the fundamental data on the flow properties of heterogeneous fluid systems. Starting from the permeability–saturation data of Leverett and Lewis, and of Wyckoff and Botset, a series of curves have been derived for $\frac{k_g}{k_o}$ and $\frac{k_w}{k_o}$ against oil saturation for different water saturations, of $\frac{k_o}{k}$ against $\frac{k_g}{k_o}$ for different water saturations, and of $\frac{k_o}{k}$ against water saturation for different values of $\frac{k_g}{k_o}$. k is the permeability, and the subscripts o, g, and w refer to the oil, gas, and water phases. The next step involved the determination of the reservoir oil and water saturations required to give specified values of gas–oil ratio and water–oil ratio. These data permit the drawing of curves showing the variation of gas–oil ratio with oil saturation for fixed values of water saturation. Curves for the water–oil ratio plotted against water saturation for different gas–oil ratios are given, and also curves for water–oil ratio against the oil saturation–water saturation ratio, which are relatively insensitive to changes in gas–oil ratio.

The curves show that with the gas–oil ratio and water–oil ratio given it is possible, in principle, to calculate the reservoir saturations, and hence the permeabilities and productivity factor. Conversely, the reservoir saturations can be used to deduce the gas–oil ratio, the water–oil ratio, and the productivity factor.

While the numerical results of the calculations cannot be applied directly to field conditions, because they are based on permeability data for uncemented sands and involve specific assumptions regarding the nature of the reservoir fluids, the methods of analysis and interpretation should have significance in considering certain specific field conditions when the necessary field and laboratory data become available. It seems likely that even under the idealized conditions to which the numerical calculations refer they should serve to give at least the order of the magnitude of the effects of gas–oil ratio and connate water on the observed productivity factors. Within the indicated limitations the computations imply that the foregoing factors can explain only a part of the apparent discrepancy between the homogeneous fluid productivity factors and those obtained recently in field measurements on the West Coast.

G. D. H.

25. Dimensional-Model Studies of Oilfield Behaviour. M. C. Leverett, W. B. Lewis, and M. E. True. *Petrol. Tech.*, January 1942, **5** (1), A.I.M.M.E. Tech. Pub. No. 1413, 1–10.—The theory underlying the design of two kinds of dimensionally scaled models of parts of idealized oil-fields is given, and the construction and operation of the models are described. The unique features in the design of the models are: (1) the treatment of the permeability–viscosity quotient as a single variable, and (2) the use of previously reported experimentally developed relationships between relative permeability and saturation, and between capillary pressure, saturation, porosity, permeability, and interfacial tension. The models simulate the flow of oil and water only through uncemented sands.

One model represents an oil-well and its surrounding sand for a distance of 16 ft. radially from the well, and is designed to study the effects of various methods of well completion. Data which are presented show the effect of production rate on water-coning. In the other model the effect on recovery, by water-flooding, of a patch of fine sand within a coarse sand is capable of being investigated for linear flow. The experiments in this case showed a higher total recovery from the sands at low rates of flow than at high rates of flow.

These models are superior to unscaled models, which may give rise to erroneous conclusions. Thus the models include such features as boundary effect in their more nearly correct significance than in short tube experiments.

The limitations of the model technique are discussed. G. D. H.

26. The Electrical Resistivity Log as an Aid in Determining some Reservoir Characteristics. G. E. Archie. *Petrol. Tech.*, January 1942, **5** (1), A.I.M.M.E. Tech. Pub. No. 1422, 1–8.—The usefulness of the electrical resistivity log in determining reservoir characteristics is governed largely by: (1) the accuracy with which the true resistivity of the formation can be determined; (2) the scope of detailed data concerning the relationship of resistivity measurements to formation characteristics; (3) the available information concerning the conductivity of connate or formation waters; (4) the extent of geological knowledge regarding the probable changes in facies within given horizons, both vertically and laterally, particularly in relation to the resultant effect on the electrical properties of the reservoir.

A series of brine-saturated cores have been examined, and it was found that the following simple relationship holds between R_0 (resistivity of the sand when saturated with brine), R_w (resistivity of the brine), and F (a "formation resistivity factor"): $R_0 = FR_w$. Also $F = \theta^{-m}$, where θ is the porosity fraction of the sand, and m is a constant ranging 1·8–2·0 for consolidated sandstones, and being about 1·3 for clean uncemented sands. For sands with the pores partly filled with connate water and the rest of the pores occupied by oil or gas, $S = \sqrt[n]{\frac{R_0}{R}}$, where S is the fractional water saturation, R the measured resistivity, and n a constant which is about 2. In practice R may be derived from an electrical log after making due allowance for certain factors. R_0 may at times be derivable from electrical logs, but otherwise it must be determined from measurements of θ, m, and R_w.

Electrical log values of R must be corrected for the presence of the borehole and the thickness of the layers in the formations in relation to the electrode spacing. Calculated tables show the approximate influence of these two factors. Invasion of

the formation by the mud filtrate may also affect the measured values, although mud conditioning may keep this factor small.

Examples are given of the calculation of the connate water content of a reservoir from electrical log measurements and other data. It is also possible to obtain a measure of the amount of invasion by mud filtrate. G. D. H.

27. Unsteady Flow of Gas through Porous Media. C. R. Hetherington, D. T. Mac. Roberts and R. L. Huntingdon. *Petrol. Tech.*, January 1942, **5** (1), A.I.M.M.E. Tech. Pub. No. 1398, 1–9.—Since the equation of continuity governing the transient flow of gases through porous media cannot be integrated mathematically into a simple usable expression free from series terms, empirical and approximate equations have been advanced relating cumulative production and future production rates from gas reservoirs with time. In order to check the accuracy of these empirical equations and to obtain an insight into the initial conditions pertinent to the solution of the fundamental equation of continuity, experimental work has been conducted on a vertical 2-in. tube, 91·6 ft. high, packed with loose Wilcox sand. The sand had a porosity of 33% and a permeability of 7·2 darcys, and it was found that turbulence set in at a Reynolds number of 1·00–2·00.

Close agreement was obtained with the "characteristic equation" of the "back-pressure" method of testing gas wells: $\frac{Q}{T} = a(P_s^2 - P_f^2)^N$, where Q is the total production to the time T, P_s the pressure at the external boundary of the system, P_f the pressure at the outlet of the system, and N an experimental constant. Curves show the pressure distribution at different times, the pressure change with time at different stations, the change of rate of flow with time, the increase in cumulative production with time, and the relationship between pressure and cumulative production at different stations.

It was found that after about three or four minutes the rate of pressure decline was essentially independent of the position in the system, and in this phase the equation

$$Q = Q_0\left[1 - \left(\frac{1}{1 + \frac{(2N-1)C_0T}{Q_0}}\right)^{\frac{1}{2N-1}}\right]$$

gave better agreement with observations than for the initial phase. Q_0 is the initial quantity of gas in the reservoir, C_0 the initial rate of flow, and the other symbols have the same significance as before. The initial 3 or 4 min. constitute a transient period which has been inferred from field data, and which is probably of longer duration than is commonly supposed.

The experiments tend to verify the accuracy of the "back-pressure" method of testing gas-wells, provided that the period of transient conditions for the reservoir is not of too long a duration. The assumption of successive steady states is seen to hold with fair validity in calculating future production and rates of decline.

G. D. H.

Transport and Storage.

28. Engineering Economics of Long Petroleum Pipe-lines. E. G. Hill. *Petrol. Tech.*, January 1942, **5** (1), A.I.M.M.E. Tech. Pub. No. 1433, 1–13.—The engineering and economic aspects of the design of long petroleum pipe-lines are discussed, with special reference to the following points: application of basic flow formulæ; comparative costs of lines; capacities of lines and cost per mile; effect of viscosity on the over-all transportation costs; basic costs of transporting crude oil; the effect of increased line size on costs; the functions of pipe-lines for refined products; the handling of different products through pipe-lines; basic principles governing the flow of gasoline through pipe-lines; and the importance of a high load factor.

Diagrams show the approximate daily delivery capacity at 100% load factor of oil and gasoline for lines of different diameters with a 15 lb./in.² pressure drop per mile; the approximate cost per mile and per mile per barrel daily capacity for different sizes; and the factors determining the pressure drop.

While the cost per mile increases as the diameter increases, the cost per mile per barrel daily capacity decreases as the diameter increases. For 10-in. and 12-in. lines

the tariff is probably 5c./brl./100 ml., but for a 24-in. line the figure would probably be 2¼c./brl./100 ml. at reasonably good load factors. A large line which might operate at 3c./brl./100 ml. at 100% load factor would probably show a cost of 3·25c. at 90% load factor, 3·6c. at 75%, and 5·4c. at 50% load factor. G. D. H.

29.* **Flow of Liquids Under Critical Conditions.** A. H. Nissan. *J. Inst. Petrol.*, November 1942, **28** (227), 257–273.—Experiments on the flow of water through a copper pipe of circular cross-section under critical regime are described, and their results analyzed. It appears that the critical regime is similar to the viscous regime in having linear relationships between frictional head and rate of flow, and it is similar to turbulent flow in the small direct influence that viscosity appears to have. A. H. N.

Cracking.

30. **Notes on the Conversion of California Residuum.** R. F. Naeve. *Refiner*, September 1942, **21** (9), 269–270.—A brief report is given of experiments on the conversion of a residuum, catalytically, into lighter products. The author requests correspondence with those interested in the problem for exchange of data and ideas. A. H. N.

31. **Patent on Cracking.** G. Egloff. U.S.P. 2,297,695, 6.10.42. Appl., 12.8.40.—A hydrocarbon distillate consisting of naphtha and heavier naphthenic oil is subjected to catalytic reforming in the presence of a powdered dehydrogenation catalyst. Resultant conversion products are passed to a secondary reaction zone, where conversion is continued in the presence of a powdered cracking catalyst. Products of this reaction are separated into cracked vapours and residue containing mixed catalysts. The cracked vapours are fractionated to form reflux condensate, which in turn is passed to the secondary cracking zone. Fractionated vapours are cooled and condensed, and the resultant distillate is separated from undissolved and uncondensed gases. At least part of these gases are returned to the primary reaction zone. H. B. M.

Hydrogenation.

32. **Patents on Hydrogenation.** B. B. Corson and G. S. Monroe. U.S.P. 2,298,346, 13.10.42. Appl. 30.10.39. Catalytic hydrogenation process for effecting substantial desulphurization of a gasoline containing both olefinic hydrocarbons and sulphur compounds in such a way that the anti-knock value of the gasoline is not materially reduced. The vapours of the gasoline are contacted with a nickel sulphide catalyst in the presence of an amount of hydrogen approximately four times as great as that required for complete hydrogenation of the olefinic hydrocarbons and removal of sulphur. The operation is carried out at a temperature of approximately 350° C., under a hydrogen pressure of approximately 900 lb. per square inch and at a liquid space velocity of between 1 and 2.

B. B. Corson and G. S. Monroe. U.S.P. 2,298,347, 13.10.42. Appl. 30.10.39. Process as described in U.S.P. 2,298,346 above, except that a heavy metal sulphide is employed instead of a nickel sulphide catalyst. H. B. M.

Polymerization and Alkylation.

33.* **High Temperature Alkylation of Aromatic Hydrocarbons.** A. N. Sachanen and A. A. O'Kelly. *Industr. Engng Chem.*, 1941, **33** (12), 1540.—Yields and operating conditions are given for the experimental batch and continuous alkylation of benzene and toluene with the following olefins: propylene, butylene, and amylene. At atmospheric pressure this reaction takes place at 800–900° F. without the presence of a catalyst. At high pressures, in the presence of an activated clay catalyst, an improved yield of the alkylated aromatic is obtained. Yields of alkyl benzene may be as high as 67% and as high as 83% for alkyl toluene. J. W. H.

34. Patent on Polymerization and Alkylation. V. N. Ipatieff and H. Pines. U.S.P. 2,298,383, 13.10.42. Appl. 7.10.40. Substantially saturated hydrocarbons of motor fuel boiling range are produced by alkylating isobutane with ethylene in the presence of hydrogen chloride and a solid composite comprising aluminium chloride adsorbed in a solid adsorbent. H. B. M.

Synthetic Products.

35.* Ameripol—Synthetic Rubber Developed by U.S. Scientists. C. C. Pryor. *Petrol. Engr*, August 1942, **13** (12), 31.—The first experiments on the manufacture of dienes and their polymerization to produce synthetic rubber were carried out in 1926 by W. L. Semon, under whose direction the development and manufacture of Ameripol and other butadiene synthetic rubbers have been brought to a commercial basis. The first pilot plant was completed in 1939, with a capacity of 100 lb. of rubber a day, and by 1940 two distinct types of synthetic rubber had been developed, (*a*) a tyre rubber, and (*b*) an oil-resistant speciality rubber. Hycar Chemical Co., jointly owned by Phillips Petroleum Co. and the B.F. Goodrich Co., constructed a plant capable of manufacturing 2000 tons per annum of both types of synthetic rubber.

The butadiene molecules will readily polymerize with themselves or copolymerize with other substances to produce synthetic rubbers. When emulsified under pressure with soap and water, polymerization proceeds rapidly, resulting in a milky suspension similar to natural latex. Coagulated with acid, in much the same way as natural latex, the synthetic is sheeted, and thus is produced the synthetic crude rubber. The same equipment and almost identically the same technique are employed in compounding and vulcanizing Ameripol as are used for natural crude rubber, except that less sulphur and more accelerator are ordinarily required and larger quantities of softener may be used. Ameripol rubbers are compounded differently for each of a large number of special uses. Compounds of high tensile strength and elasticity are easily manufactured. Special compounds possessing high resistance to swelling or deterioration in the presence of petroleum products, vegetable oils, fats, etc., and others possessing special heat-resisting properties are also prepared. Some of the special applications of Ameripol, in which advantage is taken of its superiority to natural rubber for specific purposes, are listed. Synthetic Ameripol rubber for tyres is said to cost about 60c. per lb., but it is believed that a cost of 25c. lb. could be achieved in plants having a capacity of 36,000 tons per annum. R. A. E.

Refining and Refinery Plant.

36.* Mean Temperature Difference in Multipass Heat Exchangers. K. A. Gardner. *Industr. Engng Chem.*, 1941, **33** (12), 1495.—It is sometimes preferable to design heat exchangers in which the shell fluid is not mixed, and the conditions under which this is advantageous are discussed. Data are given which enable the mean temperature correction factor to be estimated for these conditions, and it is shown that the factors are higher than those for which the shell fluid is mixed. J. W. H.

37. Automatic Control of Absorption Oil Flow Improves Plant Recovery. Anon. *Refiner*, September 1942, **21** (9), 271–273.—In the plant described, sufficient quantity of absorption oil at 150 lb./sq. in. gauge is circulated to remove the propane and heavier components from the field gases. By absorbing all of the propane it is inevitable that some of the ethane will be dissolved in the absorption oil. To control this a combination tail absorber and fat-oil flash-tower is stepped into the line of absorption-oil flow. Liquid-level controllers vent the fat oil from the high-pressure absorbers directly into the combination column, which reduces the pressure on the oil from 150 to 50 lb. This immediate drop in pressure releases the undesirable fractions together with some of the more desirable ones, which, if not checked, would flow into residue gas-lines. Since the recovered vapours from the accumulator and storage tanks are gathered and compressed and piped to the combination column, a quantity of lean absorption oil is pumped over this tower, so that none of the desirable fractions will escape. The lean oil enters the column above the absorbing trays, while the fat oil from the high-pressure absorbers enters below the bubble-plates. The oil

flowing down in contact with the rising vapours merges with the fat oil and passes outward to the distillation system.

In combination with this system of pre-stabilization of the fat absorption oil, a surge tank is placed in the line of flow between the flash column and reabsorber and the fat-oil pumps. Liquid-level controllers vent the oil from the base of the combination column to the surge-tank, which is equipped with both a high and a low liquid-level controlling installation, each working independently, but both hooked-up to operate the diaphragm valve in the steam line to the fat-oil pump. When the operation of the plant is on a basis of constant flow of absorption oil, the level-controllers float in their cases and the fat-oil pump runs at sufficient speed to remove the oil from the surge-tank as rapidly as it is vented into it from the combination column. If the rate of flow changes only slightly from the normal rate, the high- and low-level controllers act to establish equilibrium by changing the speed of the fat-oil pump. A. H. N.

38. More Steam with Minimum Materials. P. W. Foster, Jr. *Refiner*, September 1942, **21** (9), 265–268.—The present scarcity of raw materials has made it difficult, if not impossible, to secure additional steam for increasing refinery requirements by the installation of new boilers of conventional design. Therefore when an increase in total steam production is needed, new ways of accomplishing this by the use of a minimum amount of critical material must be devised. Furthermore, as this additional steam requirement may end at the termination of the war, it is essential that the cost of the steam-generating equipment be kept to a minimum. Some methods of doing this have already been developed, but there are also new ways which are worthy of consideration. The paper discusses the use of waste-heat boilers and of combination direct-fired boiler and still. Definite saving in material and first cost can be made by installing steam-generating surface in combination with an oil-heater, as compared with the cost of a separate direct-fired boiler and an oil-heater. A single boiler unit to give 100,000 lb. of steam/hour is cheaper than two 50,000 lb./hr units. On the same basis if 50,000,000 B.t.u./hr. is put into oil, and 25,000,000 B.t.u./hr. into steam, a combined unit is cheaper in first cost, and in material required, than a separate oil-heater and boiler for the same capacities.

The paper ends with the following conclusions: Heating oil and generating steam in the furnace of an oil-heater have the following advantages: (1) The first cost of the steam-generating and oil-heating equipment is reduced. (2) The total material required for steam generation is reduced. (3) Steam can be generated with the same efficiency as in a separate, direct-fired boiler plant. (4) The efficiency of heating the oil can be increased. (5) Auxiliary motor drives can be eliminated. When both steam and power come from a central power-plant, auxiliaries such as pumps, fans, etc., are usually arranged for both steam- and motor-drive. With a combination boiler and still, the motor-drives can be omitted, as steam will always be generated when the still is in operation. (6) Large savings in first cost and material in elimination of steam and power lines from power-station to refinery unit location. A. H. N.

39. Multicomponent Distillation. C. D. Shiah. *Refiner*, September 1942, **21** (9), 261–264.—In a previous article of this series the author has presented a graphical method for the stepwise calculations of multi-component rectification. It is probably the quickest method for carrying out the detailed calculations. The advantage of a stepwise solution lies in the fact that it gives a complete picture of the concentration gradients of each component along the plates as well as the temperature on each plate. The inherent disadvantage of this method, however, is its stepwise nature, which, in the case of a large number of plates, is unavoidably time-consuming.

This paper presents a quick method, which is simple and which gives a complete picture of the concentration gradient of each component along the column with reasonable accuracy. The methods were checked against the step-by-step method and the agreement is good. A. H. N.

40. Patents on Refining and Refinery Plant. Standard Oil Development Co. E.P. 548,375, 8.10.42. Appl. 10.1.40. In an improved solvent-treating process, separation of the highly aromatic constituents of an initial feed-oil in a pretreating zone

allows a second solvent to displace the first solvent substantially completely from the relatively intermediately soluble aromatic constituents of the feed-oil. Thus the initial solvent, so displaced by the second, can be returned to the initial extraction zones without distillation and without returning to these zones any appreciable quantity of dissolved aromatics.

C. G. Dryer and C. Wirth. U.S.P. 2,297,751, 6.10.42. Appl. 8.9.39. Method of treating a sour hydrocarbon distillate with a copper-containing sweetening agent in the presence of oxygen-containing gas. The mixture of distillate and gas is introduced into the upper portion of a vertical chamber having a free space in its upper portion and a layer of copper-removing agent in its lower. The gas is separated from the distillate, and the latter is allowed to gravitate through the copper-removing agent. In this way the time elapsing between sweetening of the distillate and removal of dissolved copper is minimized.

W. L. Benedict. U.S.P. 2,297,866, 6.10.42. Appl. 25.9.39. Method of sweetening sour hydrocarbon distillate which contains mercaptans. The distillate is treated with an alkali metal hydroxide dissolved in a solvent consisting of a relatively low-boiling alcohol and a higher-boiling alcohol. Afterwards the mercaptan-containing alcohol is separated from the treated distillate. The mercaptan-containing alcoholic solution is regenerated by vaporizing the lower-boiling alcohol from the solution. Then the mercaptans are vaporized from the remainder of the solution, thus leaving a residue containing the higher-boiling alcohol and alkali metal hydroxide. The residue is mixed with the lower-boiling alcohol and the whole passed to the distillate-treating operation. H. B. M.

Chemistry and Physics of Petroleum.

41.* Isomerization of Polymethylene Hydrocarbons under the Influence of Aluminium Chloride. M. B. Turova-Poliak and F. P. Sidel'kovskaya. Trans. from *Zhurnal Obshchei Khimii*, II, 1941, 817. *Foreign Petrol. Tech.*, Jan.–Feb., 1942, **10** (1/2).—Article VII. Isomerization of *cyclo*Heptane (pp. 7–12). The paper describes experiments concerning the behaviour of *cyclo*heptane in the presence of the isomerization-promoting agent aluminium chloride. It was found that in the interaction of aluminium chloride with *cyclo*heptane, the latter is isomerized by 97–98% to methyl*cyclo*hexane. In this way is effected the isomerization of the seven-member polymethylene hydrocarbon into a six-member one.

Article VIII. Isomerization of Hexahydromesitylene (pp. 27–30). As a result of experiments, the authors obtained through the action of aluminium chloride on hexahydromesitylene a mixture of hydrocarbons which is composed of 88% hexamethylene hydrocarbons (unchanged hexahydromesitylene), 9% pentamethylene, and 3% paraffin hydrocarbons. The group composition of separated hydrocarbons confirms the observation made previously that the derivatives of *cyclo*hexane are extremely stable towards the isomerizing effect of aluminium chloride.

Article IX. Isomerization of 1 : 2-Dimethyl*cyclo*pentane (pp. 31–37). As a result of investigations concerning the process of isomerization of 1 : 2-dimethyl*cyclo*pentane under the influence of aluminium chloride, it was found that a yield of 96·7% methyl-*cyclo*hexane is normally obtained. It was also proved that the presence of substituents in the molecule of *cyclo*pentane does not interfere with its isomerization to *cyclo*hexane hydrocarbons. H. B. M.

42.* Determination of Beattie–Bridgeman Constants from Critical Data. F. W. Brown. *Industr. Engng Chem.*, 1941, **33** (12), 1536.—A brief discussion is given on the Maron–Turnbull equation for the calculation of the Beattie–Bridgeman constants. It is shown that this equation is an expression of the law of corresponding states in terms of the intermolecular forces. The constants for hydrogen are calculated on the basis of a model of the intermolecular forces. Theoretical reasons are given for expecting deviations from the Maron–Turnbull equation. J. W. H.

43.* Viscosity Nomographs for Organic Liquids. D. S. Davis. *Industr. Engng Chem.*, 1941, **33** (12), 1537.—From relationships between viscosity, density, and

molecular weight two nomographs have been drawn which enable the viscosity of some 166 compounds to be estimated, twenty-nine of these compounds being hydrocarbons. J. W. H.

44.* Ternary Systems for Extraction Calculations. J. C. Smith. *Industr. Engng Chem.*, 1942, **34**, 234.—The theoretical methods available for the interpretation of ternary solubility diagrams are discussed and a list of ternary systems, for which the solubility data are complete, is given. The bibliography includes extensive references to theoretical and experimental work on this subject. J. W. H.

45.* Molecular Refraction Nomograph. D. S. Davis. *Industr. Engng Chem.*, 1942, **34**, 258.—A nomograph is presented which enables the molecular refraction, as expressed by the Lorentz-Lorenz formula, to be rapidly estimated. J. W. H.

46.* Molal Volume Nomographs for Aliphatic Hydrocarbons. D. S. Davis. *Industr. Engng Chem.*, 1942, **34**, 351.—The liquid molal volumes of aliphatic hydrocarbons at the boiling point are correlated against number of carbon atoms and boiling point in the form of two nomographs, which enable allowance to be made for the degree of branching in the hydrocarbon. J. W. H.

47.* Effect of Pressure on the Enthalpy of Pentane, Heptane, and *iso*Octane. E. R. Gilliland and M. D. Parekh. *Industr. Engng Chem.*, 1942, **34**, 360.—The isothermal enthalpy changes with pressure have been investigated over the pressure range 200–2900 lb./sq. in. and over a temperature range of 330–660° K. The experimental results obtained are compared with results calculated from other published data obtained by different techniques. Excellent agreement is shown at all pressure ranges except at very low values of reduced pressure, where the experimental curves were extrapolated, and hence might not be so accurate. J. W. H.

48.* Molecular Volume of Liquid Alkanes at Corresponding Temperatures. G. Egloff and R. C. Kuder. *Industr. Engng Chem.*, 1942, **34**, 372.—Correlation of the molecular volumes of the paraffin series with boiling point or melting point is not satisfactory, but it is shown that if a correlation is made between the molecular volume and the reduced temperature, there are no complications for paraffins containing up to 8 carbon atoms. J. W. H.

49.* Application of Thermodynamic Data to Industry. J. G. Aston. *Industr. Engng Chem.*, 1942, **34**, 514.—The various methods available for calculating the free energy data for a reaction are discussed, and the methods by which these values can be calculated from a knowledge of (*a*) equilibrium at two or more temperatures, (*b*) the equilibrium at one temperature and a knowledge of the heat of reaction and heat capacity, and (*c*) heat of reaction, entropy, and heat capacity data. Examples of the use of these methods are applied to the isomerization of *n*-butane and to the hydration of ethylene. A method is also given by which the pressure effects on free energy calculations can be estimated. J. W. H.

50.* Prediction of Critical Constants. H. P. Meissner and E. M. Redding. *Industr. Engng Chem.*, 1942, **34**, 521.—Equations are given which enable the critical pressure, temperature, and volume to be calculated from a knowledge of the boiling point, vapour pressure, and liquid density at some temperature. These equations have been derived from data on 100 substances, and can be applied to any substance which is not highly associated and the structural formula of which is known. J. W. H.

51.* Applications of Thermodynamics to Multicomponent Systems. B. H. Sage and R. H. Olde. *Industr. Engng Chem.*, 1942, **34**, 526.—The value of the fugacity in the estimation of phase behaviour in multi-component systems is discussed, and the value of enthalpy in studying the behaviour of multi-component homogeneous systems is reviewed. The manner in which the enthalpy can be used to study the change of state, work, and heat associated with both steady and transient flow conditions is demonstrated. J. W. H.

52.* Compressor Design for the Process Industries. R. York. *Industr. Engng Chem.*, 1942, **34**, 535.—The design and performance of compressors for the com-

pression of perfect gases are discussed from a theoretical aspect, and the methods by which the fundamental equations can be modified for dealing with non-ideal gases are reviewed. A numerical example is given of a compressor operating on an imperfect gas mixture. J. W. H.

53.* Generalized Thermodynamic Properties of Gases at High Pressures. S. H. Maron and D. Turnbull. *Industr. Engng Chem.*, 1942, **34**, 544.—The advantages and limitations of the following methods of obtaining compressibilities and thermodynamic properties of gases at high pressures are discussed: (*a*) direct experimental study, (*b*) experimental measurements of compressibilities and evaluation from these of the various thermodynamic properties, (*c*) the fitting of equations of state to determined *P–V–T* data and the analytical calculation of the thermodynamic properties, (*d*) estimation of the compressibilities and thermodynamic properties from the generalized graphical correlations of the theorem of corresponding states. J. W. H.

54.* Degrees of Freedom in Multicomponent Absorption and Rectification Columns. E. R. Gilliland and C. E. Read. *Industr. Engng Chem.*, 1942, **34**, 551.—An analysis is made to determine how many of the design variables may be arbitrarily fixed before the system as a whole can be physically defined in equilibrium and non-equilibrium contacting systems. From this point it is shown that the greatest difficulty in applying any of the existing methods of design is that it is necessary to fix more variables than are independent in order to expedite the process design as a whole. Thus the rapidity with which these methods can be evaluated depends to a certain extent on the experience with which the initial assumptions can be made. J. W. H.

55.* Vapour–Liquid Equilibria of Non-ideal Solutions. H. C. Carlson and A. P. Colburn. *Industr. Engng Chem.*, 1942, **34**, 581.—Several equations, based on thermodynamic principles, are reviewed which enable vapour–liquid equilibria in non-ideal solutions to be correlated. These equations enable experimental data to be examined critically for accuracy. With an integrated form of one of these equations complete vapour–liquid equilibria may be calculated from measurements of azeotropic composition, total pressure or boiling-point curves, or liquid–liquid solubility. The use of these equations to calculate the effect of pressure or temperature on the equilibrium composition is demonstrated, and the manner in which data on three binary systems can be applied to the estimation of ternary data is shown. A short note on the value of activity coefficients in the calculation of extraction equilibria is also given. J. W. H.

56.* Thermodynamic Properties of Light Hydrocarbons. D. E. Holcomb and G. G. Brown. *Industr. Engng Chem.*, 1942, **34**, 590.—The thermal properties of hydrocarbons and hydrocarbon mixtures covering the pressure range 0–10,000 lb./sq. in. and the temperature range of − 200 to + 1100° F. for the vapours, and from 0° to 320° F. for the liquids are presented in graphical form. In addition to this thermal data, the compressibility factors and activity coefficients are given, which enable extensive thermodynamic properties to be calculated.

Actual examples are given illustrating the following applications of the data given: overall heat balance on a high-pressure absorber, heat balance for a natural gasoline fractionator, the construction of an enthalpy–entropy (Mollier) diagram for a natural gas and the use of this chart in determining the H.P. required to compress the gas isothermally and adiabatically and to estimate the temperature change on free expansion through a valve. J. W. H.

57. Density of Liquefied Petroleum Gas Hydrocarbons. Their Mixtures and Three Natural Gasolines. B. R. Carney. *Refiner*, September 1942, **21** (9), 274–282.—*Paper Presented at the Annual Meeting of Natural Gasoline Association of America.* It is pointed out that in loading liquefied petroleum gases it is necessary to convert volumes at actual loading temperatures into standard volumes at 60° F., or vice versa. Bulk transactions in these products are becoming increasingly common, and for such deals reliable and generally acceptable volume-correction factors are desirable. The various standards in use do not agree well—particularly in the temperature range below 60° F. Also it was felt that the temperature range covered by these standards was somewhat too limited for all possible requirements.

Accordingly the original rather modest programme of checking densities for the

temperature range 0–60° F. was extended to a range of − 50° to 140° F., and at the request of the A.P.I. Committee on Measuring, Sampling, and Testing Natural Gasoline, some tests were made on typical natural gasolines of low, medium, and high volatility. Also a few determinations were made on propylene and butene-I. The direct results are orthobaric absolute densities for the individual hydrocarbons, two component mixtures, and the three natural gasolines. From these data can readily be computed the required temperature *v.* volume factors, using the density at 60° F. as a reference point.

The paper discusses in detail the apparatus, technique, and results of measuring these densities. Full tabulated and graphical data are presented. The densities of propane, *iso*butane, *n*-butane, normal pentane, and of the two olefines, propylene and butene-I, as determined in this work are compared with values obtained by other workers.

Certain of the data on the mixtures do not permit the conclusion that the two-component mixtures behave as perfect solutions. Nevertheless, even for this blend temperature–volume factors at 100° F. based on the observed and the calculated densities vary by less than two units in the third decimal place, being respectively 0·9422 and 0·9403. Based on these results, which confirmed previous investigations in the laboratories of a member company, it was concluded that for the commercial liquefied petroleum-gas products, densities, and volume factors at various densities could be ascertained by interpolating between the values for the pure compounds using the density or specific gravity of the mixture at 60° F. to identify it. The Bureau of Standards has used this same method in applying the earlier work of Dana to this problem.

Accordingly a graph was prepared plotting the data isothermally with respect to specific gravity (density) at 60° F. The correlation with specific gravity is considered commercially accurate for the liquefied petroleum-gas products—which usually consist of two or three closely related components, over the entire temperature range, − 50° to 140° F. Beyond the liquefied petroleum-gas range, *i.e.*, for specific gravities above 0·600, the correlation is likewise considered commercially accurate for the narrower temperature range 0–100° F. By commercially accurate is meant that the volume correction factors will be correct to one unit in the third decimal place. For the extreme temperature range, − 50° to 0° F., and 100–140° F. and above 0·600 specific gravity the data are less accurate, but perhaps represent the best information available in these ranges. A. H. N.

58. Hydrocarbon Structure of Petroleum is Complex. A. W. Trusty. *Refiner*, September 1942, **21** (9), 257–260.—It is explained that knowledge of the structure of petroleum is still comparatively meagre. The hydrocarbon analysis of a petroleum product heavier than natural gasoline is very complicated. Difficulty in analysis by fractional distillation and other methods are due to : (1) Difference in boiling points of hydrocarbons diminishes with increasing molecular weights. (2) The number of isomers increases rapidly with increasing molecular weights. (3) Constant-boiling mixtures. (4) Polymerization and depolymerization occurring before the boiling point is reached. A simple study of isomers and the number of possible isomers for hydrocarbons of certain number of carbon atoms is given. Classification of crudes is briefly discussed, followed by a study of hydrocarbons in gas, gasolines, kerosine, etc.

The hydrocarbon structure is so complex and the number of hydrocarbons present in lubricating oils so great that very little success has been had in isolating pure hydrocarbons therefrom. Several investigators have studied synthetic hydrocarbons and have made deductions regarding the chemical composition and nature of the heavy, viscous oils. Hugel has concluded : (1) Ring formation has a great effect in increasing viscosity. (2) The branching chains in acyclic hydrocarbons have little or no effect on viscosity. (3) Unsaturation (olefins) has very little effect on viscosity in acyclic hydrocarbons, although it may be a factor in cyclic compounds. (4) In general, a cyclic nucleus in a molecule is necessary if such factors as branching of the chain or unsaturation are to have any effect on viscosity, and in acyclic compounds viscosity is materially increased only by increasing the molecular weight. (5) Of two oils with the same viscosity at a given temperature, say 100° F., the oil with the lower molecular weight is characterized by greater viscosity change with change in temperature.

The lubricating fraction of a Mid-Continent petroleum from which the wax and

asphaltic constituents had been removed appears to have the following constitution: (1) About 60% of the material consists of naphthenes with from one to three rings/molecule (a very small amount of material containing four naphthenic rings is probably present also). (2) About 15% of the material consists of molecules with one aromatic ring and from one to three naphthenic rings/molecule, and with this material is associated a small amount of sulphur and oxygen compounds. (3) About 14% of the material consists of molecules with two aromatic rings (linked through two common carbon atoms) and about two naphthenic rings/molecule, and with this material is associated a small amount of sulphur and oxygen compounds. (4) About 11% of the material consists of molecules with more than two aromatic rings (each probably linked through two common carbon atoms) and one or two naphthenic rings/molecule, and with this material are associated some sulphur, nitrogen, and oxygen compounds.

A. H. N.

59.* Interstitial Flow. R. T. Hancock. *Min. Mag.*, October 1942, **67** (4), 179–186.—All that the author claims in this article is a brief introduction to a wide subject—namely, the nature of the relations between solids and liquids when they are moving relatively to one another. Among the considerable ramifications of the subject, the paper is relevant to the flow of oil towards wells and springs, and is, in fact, an investigation of the resistance encountered by a fluid as a function of its velocity.

Factors which affect behaviour include such things as diameter of channel or particle, velocity of flow or movement, specific gravities of the solid and fluid, fall in pressure over unit distance, loss of kinetic energy through friction or by conversion into potential energy, and the nature of the flow, *i.e.*, whether viscous or turbulent.

Physicists have made important discoveries concerning the nature of flow through smooth pipes and the nature of fall of smooth spheres in liquids. The relations can be expressed in a manner which shows their absolute applicability to a wide range of conditions by plotting them in the form of dimensionless co-ordinates. The present treatment is based on this method of presentation.

The author reaches the conclusion that in the case of immobilized beds and of suspensions the resistance experienced by a fluid traversing them may be expressed in dimensionless co-ordinates by :

$$R = \frac{vd\rho}{\mu}$$

$$\Psi = \frac{4}{3} \cdot \frac{gd}{\rho v^2} \cdot \frac{P}{L\lambda} \cdot \phi \text{ (voidage)}$$

where the function in the case of suspensions is $(1 - \lambda)^6$ and in the case of beds is $\gamma (1 - \lambda)^4$.

The following (usual) notation is employed in this paper :

g = gravitational constant, 981 cm./sec.^{2}
μ = viscosity of the fluid or gas, gm./sec.cm.
ρ = density of the fluid or gas, gm./cm.^{3}
s = specific gravity of the solid, gm./cm.^{3}
P/L = pressure drop over unit distance, gm./cm.^{3}
d = diameter of solid or pipe, cm.
v = velocity of fall or flow, cm./sec.
$(1 - \lambda)$ = ratio of fluid to total volume, dimensionless.
λ = ratio of solid to total volume, dimensionless.
R = Reynold's number, dimensionless.
Ψ = the resistance coefficient, dimensionless.

H. B. M.

Analysis and Testing.

60. Rapid Method for the Determination of Tetraethyl Lead in Leaded Gasolines. M. P. Khaikin. Trans. from *Prikladnoi Khimii*, 1941, **14** (4/5), 13–26.—The molybdate method for the determination of tetraethyl lead has for some time past been employed in Russia. It is, however, a complex method involving several reagents, including a titrated solution of ammonium molybdate and a great deal of time. This paper describes a new gravimetric method for the determination of tetraethyl lead, which, because of its simplicity, should prove of particular value for the operation of automobile depots.

100 ml. of the gasoline under test are placed in a weighed Erlenmayer flask, and a 10% solution of bromine in carbon tetrachloride is added drop by drop to complete precipitation of lead bromide. After a final ml. of the bromine has been added to ensure complete precipitation, the liquid is carefully decanted through a filter-paper. The precipitate formed in the flask is decanted a few times with petroleum ether, which is decanted through the same filter.

The neck of the flask is washed with a boiling hot 15% solution of nitric acid. The funnel, with the filter, is placed in the flask, and the precipitate on the filter dissolved by the same solution of nitric acid. The dissolution is carried out with three portions of the solution of the acid, using 10 ml. each time. The filter is then opened and again washed over the funnel, and the latter is then washed over the neck of the flask.

The solution obtained is heated to boiling point and is left on the hot plate until 3–5 ml. of the solution remain. The rest of the solution is disposed of by gentle heating, and the separated precipitate is dried (not over 200° C.) until vapours disappear, also the odour of nitrogen oxides. The flask with the residue is cooled in a desiccator and weighed. H. B. M.

61. Optical Rotation of Petro eum Fractions. M. R. Fenske, F. C. Carnahars, J. N. Breston, A. H. Caser, and A. R. Rescosla. *Industr. Engng Chem.*, 1942, **34** (5), 638.—Measurements of the rotary power of distillate fractions from Oklahoma and other crude oils have been made which show that a rotational maximum is reached between the gas oil and lubricating-oil fractions. The magnitude of the rotation is a function of the geographical origin of the crude. Concentration of the optically active material by distillation is less effective than by solvent extraction. The optically active components are concentrated in the non-aromatic portion, but do not appear to be due to any one compound. The optically active constituents are unchanged by treatment with anhydrous aluminium chloride, sulphuric acid, clay, or use in an engine. J. W. H.

Motor Fuels.

62. Patents on Motor Fuels. E. R. Kanhofer. U.S.P. 2,297,773, 6.10.42. Appl. 31.7.42. Method of production of a motor fuel having a high octane rating and a relatively low olefin content. The process involves subjecting a hydrocarbon oil to catalytic cracking at a temperature between 800° and 1200° F. for a sufficient length of time to form olefinic gasoline. The resultant products are fractionated to separate the olefinic gasoline. Afterwards a saturated hydrocarbon oil is mixed with the olefinic gasoline, and the mixture is contacted with a cracking catalyst at a temperature between 500° and 800° F. for a longer period of time than was maintained in the first catalytic cracking operation. In this way the major portion of the olefin content of the gasoline is saturated and a gasoline of relatively low olefin content can be recovered.

E. R. Kanhofer. U.S.P. 2,297,775, 6.10.42. Appl. 31.7.39. Production of motor fuel of high octane rating and low olefin content by thermally cracking hydrocarbon oil heavier than gasoline. The resultant cracked gasoline-containing vapours are passed to a fractionating zone maintained at a temperature above the boiling point of the gasoline. In addition there is introduced into the fractionating zone a heavy hydrocarbon charging oil containing sufficient hydrocarbons, vaporizable under conditions prevailing in the zone, to saturate the greater part of the olefin content of the gasoline. The cracked vapours and charging oil in the zone are fractionated, and the resultant heavy reflux condensate and residual charging oil are passed to the thermal cracking operation to provide the oil heavier than gasoline. The cracked gasoline and a portion of the saturated components of the charging oil are removed from the fractionating zone and supplied to a catalytic conversion zone. The mixture is subjected to the action of a cracking catalyst at a temperature between 500° and 800° F. and for a sufficient length of time to saturate the major portion of the olefin content of the cracked gasoline. Vaporous products of the catalytic treatment are fractionated and condensed.

P. L. Cramer. U.S.P. 2,299,801, 27.10.42. Appl. 22.7.38. Process for the production of a mixture of highly-branched-chain amylenes consisting for the most part of substantially pure trimethyl ethylene and *unsym.*-methyl ethyl ethylene. The

process includes treatment of a mixture of amyl alcohols containing dimethyl ethyl carbinol and amyl alcohols with dilute sulphuric acid to dehydrate selectively only the dimethyl ethyl carbinol. H. B. M.

Lubricants and Lubrication

63.* Lubrication of Mine Plant. C. H. S. Tupholme. *Min. Mag.*, March 1942, **66** (3), 99–104.—The author points out that one of the most important factors of crushing machinery maintenance is efficient lubrication of grinders and pulverizers. For crusher bearings it is necessary to employ a lubricant possessing considerable body in order to prevent undue heat. Fortunately there is no objection to the use of a heavy lubricant from the standpoint of speed of operation.

In mine service ball- or tube-mill bearings of the trunnion type many lubricating problems arise, due for the most part to the heavy loads which must be carried, overheating of the trunnions, and dust and grit which may work between the bearing surfaces. The use of an oil or grease having considerable body and a high liquefying point is advocated for bearings of this type.

Attention has lately been paid to the development of suitable means for automatic lubrication of bearings of the two-part type having a cap lined in much the same way as a standard type of plain bearing. Oil is carried in a reservoir below the bearing, and is distributed by a dipper device, which is rotated by the shaft. Usually two dippers are provided, which at each rotation automatically fill themselves, and then empty along the top of the shaft, whence oil is distributed throughout the entire clearance space. In cases where the pinion shafts of ball- and tube-mills are carried by ring-oiled bearings it has been found that the most suitable lubricant is a machine oil of 200–300 sec. Saybolt viscosity at 100° F.

The adoption of wick-feed oilers in the lubrication of trunnion bearings has ensured more positive results and rendered the entire operation more dependable by reducing bearing wear.

As regards vertical crushers of the type employing four balls which roll around the internal circumference of a wearing ring at the rate of approximately 160 times per minute, a heavy oil or grease should be used for main-shaft bearings. The intermediate bearing, because of its inaccessibility, is more suitably lubricated with grease. The lower bushing and thrust bearing are arranged to operate in a bath of oil. For this type of lubrication steam cylinder or crusher oil may be used, except in circumstances where the gear-drive and ball-thrust bearing are incorporated in the same housing.

Screening plant presents many problems of lubrication, especially in regard to gears which are subjected to contamination by dust, dirt, and moisture. The most effective way of protecting gearing is to employ a lubricant which will form a film to counteract the abrasive effect of such particles, and which will at the same time function irrespective of temperature, moisture, or weather conditions. A straight mineral residual product of fairly inert characteristics will probably give the best results.

For vibrating screens some form of compression or pressure-grease lubrication designed to employ a medium-bodied grease will ensure as positive results as possible.

In the case of belt-conveyors the adoption of anti-friction bearings and positive lubrication with a low-torque grease capable of functioning over a wide temperature range has proved advantageous, particularly from the standpoint of reduction of power consumption. H. B. M.

64.* A Note on the Use of Active Magnesia for the Regeneration of Used Lubricating Oils. G. Armstrong Smith. *J. chem. metall. min. Soc. S. Africa*, May–June 1942, **42** (11 and 12), 321–325.—Both small- and large-scale tests have been carried out in an endeavour to overcome a difficulty experienced in the use of active magnesia in the regeneration of used oils on a commercial scale. It has been found that this material tends to clog the filter and may eventually cause the flow of re-refined oil to cease altogether.

The author's account of these experiments points to certain definite conclusions. Much depends on the state of division of the magnesia. It would appear that the optimum time of grinding lies between 1 and 2 hr. This gives a powder having approximately 60–70% − 240 mesh, 70–80% − 200 mesh, and 85–95% − 120 mesh

material. After this stage had been reached longer grinding only very slowly increased the proportion of — 240-mesh size, while the existing — 240 particles appeared to suffer further pulverization to an extremely fine powder which materially decreased the filtration rate.

Of a number of filter-aids examined, only kieselguhr and sawdust proved useful, and on the whole kieselguhr appeared less efficient than sawdust. Carbon residue and oxidation tendencies of the oil were not affected by the use of sawdust, but a small increase in saponification value was noted.

As viscosity of the oils increases, filtering tends to become slower. In fact, though, only the heaviest grade of oil utilized (S.A.E. 40) was found to require an increased weight of sawdust for it to be comparable with the other grades (S.A.E. 20 and 30).

The use of a mixture of active magnesia and imported bentonite which has greater activity results in a reclaimed oil of somewhat better colour, and the filtration rate is fair, due to the reduction of magnesite and to the clay acting to a certain extent as a filter aid.

To complete the investigations a number of tests were carried out on a 20-gal. oil-regeneration plant in commercial operation.

From all experiments it would appear that for the commercial production of magnesia the following points should be borne in mind. Calcination must be controlled and temperatures higher than 800–850° C. avoided. The burning should be as complete as possible, so that not more than 4–5% carbon dioxide remains in the charge. Afterwards crushing to predetermined grade sizes will give a material which can satisfactorily be used with 25% bentonite or other approved filter aid. H. B. M.

65. Patents on Lubricants and Lubrication. P. S. Clarke and M. T. Flaxman. U.S.P. 2,298,080, 6.10.42. Appl. 19.11.40. Preparation of an oil of suitable type for breaking-in internal-combustion engines. The lubricant consists of a mineral lubricating oil of high viscosity index, a minor proportion of esters of low aliphatic alcohols from synthetic alcohols, and a minor proportion of the calcium soap of phosphonic acids prepared from high-viscosity-index mineral lubricating oils.

A. T. Knutson. U.S.P. 2,298,301, 13.10.42. Appl. 12.8.38. Production of a lubricating composition consisting of a mineral lubricating oil and from 0·1% to 20% of a halogenated hydro-aromatic ketone having a vapour pressure less than atmospheric at 140° C.

H. G. Smith. U.S.P. 2,298,317, 13.10.42. Appl. 27.8.40. Lubricating greases substantially free of occluded gas and vapours are prepared by agitating a grease mixture including a lubricating oil and a soap in a kettle closed to the atmosphere and under a sufficient vacuum to prevent the trapping of occluded gases and vapours.

C. F. Prutton. U.S.P. 2,298,637, 13.10.42. Appl. 4.10.39. Preparation of an extreme-pressure lubricant consisting of a major proportion of a refined mineral lubricating oil and a minor amount of a stable, oil-soluble extreme-pressure addition agent having a vapour pressure less than atmospheric at 140° C. The effectiveness of the addition agent is dependent on its ability to react chemically with the metallic surfaces to be lubricated. The composition also has incorporated in it a small amount of an oil-soluble organic nitrogen and sulphur-containing corrosion inhibitor which does not affect the extreme-pressure lubricating properties of the composition.

C. F. Prutton. U.S.P. 2,298,638, 13.10.42. Appl. 4.10.39. Extreme-pressure lubricant of the type described in U.S.P. 2,298,637 above, but containing as corrosion inhibitor an oil-soluble organic oxygen.

C. F. Prutton. U.S.P. 2,298,639, 13.10.42. Appl. 4.10.39. Extreme-pressure lubricant of the type described in U.S.P. 2,298,637 above, but containing as corrosion inhibitor an oil-soluble organic sulphur.

C. W. Muessig. U.S.P. 2,298,833, 13.10.42. Appl. 28.3.40. Preparation of a lubricant consisting of a lubricating oil blended with a minor proportion of a halogenated high-molecular-weight polymer of a normal mono-olefin containing two to three carbon atoms per molecule.

A. A. Schilling and R. B. Curran. U.S.P. 2,298,844, 13.10.42. Appl. 15.2.40. Preparation of a substantially solid bullet lubricant which has incorporated in it a

mineral wax-like lubricant and not less than 5% of a microcrystalline petrolatum wax.

D. L. Wright. U.S.P. 2,298,855, 13.10.42. Appl. 21.10.39. Preparation of a steam cylinder lubricant which has in combination a steam-reduced cylinder oil of viscosity at least 100 secs. Saybolt at 210° F. and a minute quantity of poly*iso*butylene, also from 3% to 20% of auxiliary fatty material.

L. A. Mikeska. U.S.P. 2,300,131, 27.10.42. Appl. 29.9.37. Preparation of a lubricant consisting of a hydrocarbon oil and a small amount of a polymer of a reactive-group-containing fatty acid ester of an aromatic hydroxy compound. The ester contains more than ten aliphatic carbon atoms. H. B. M.

Asphalt and Bitumen

66. Patents on Asphalt and Bitumen. D. E. Carr. U.S.P. 2,298,612, 13.10.42. Appl. 16.6.39. A bituminous emulsion of low viscosity is produced by separating salt contained in asphalt to produce an asphalt containing less than 0·005% by weight of a water-soluble inorganic salt of a divalent metal, and less than 0·005% by weight of a water-soluble salt of a monovalent metal. The asphalt is mixed at a high temperature with water and an emulsifying agent.

L. D'Antal. U.S.P. 2,299,469, 20.10.42. Appl. 28.6.37. Method of treating bitumen and other material of asphaltic character which includes heating the original substance with up to 25% by weight of a material selected from the group consisting of vegetable and animal oils, fats, and fatty acids. The residue is raised to a temperature of about 250° C. under sufficient pressure to prevent material escape of sulphur dioxide, in the presence of a substance of the group consisting of inorganic acids of sulphur containing at least four oxygen atoms and their anhydrides. Heating is continued until there is no free acid left in the reaction mass.

A. Holmes. U.S.P. 2,300,119, 27.10.42. Appl. 21.10.39. Preparation of a light-coloured plastic material from an asphaltic base crude. The petroleum oil is distilled to obtain a black residual oil, which in turn is digested with a naphtha of about 86° A.P.I. gravity. Undissolved bodies are separated, and the naphtha solution is treated with a decolorant. After treatment the decolorant is separated and a light-coloured bituminous plastic material is precipitated from the naphtha solution by the fractional addition of an oxygenated organic solvent, selected from the group consisting of alcohols, ethers, and ketones. The solvent is miscible with the naphtha, but the light-coloured bituminous plastic materials are insoluble in it. H. B. M.

Special Products.

67.* Corona Discharge on Liquid Dielectrics. J. Sticher and J. D. Piper. *Industr. Engng Chem.*, 1941, **33** (12), 1567.—The effect of a corona discharge on hydrocarbons is to form a coloured polymer, and it is this substance which results in the development of a high power factor. This polymer is unsaturated, and although the extent of the unsaturation is not high, the reactivity is great. Part of the polymer appears soluble in the hydrocarbon from which it was derived, and part of it appears in the colloidal state, indicating that it may be classed as a hemicolloid. Hypotheses are put forward to account for the development of the high power factor. J. W. H.

68. Black-out Paints. C. R. Draper. *Paint Mnfr.*, March 1942, **12** (3), 47–50; April 1942, (4), 77–78.—In a consideration of the various materials available for the manufacture of black-out paints, the author discusses the use of coatings of the bituminous emulsion type. These possess the big advantage of easy removal by solvent after the film has dried out. A great disadvantage is that they are liable to be affected by very wet conditions, such as frequently obtain on roof lights, etc. A further disadvantage of such films is their low opacity, owing to the comparatively low pigment content which can be carried. It is usually advisable to apply two coatings to improve opacity for black-out purposes.

The author points out that conditions for emulsification vary considerably, according to the grade of material employed. Frequently it is not necessary to add a dispersing agent, though some alkali should be present in the aqueous phase which will react with acidic constituents in the bitumen and produce emulsifying agents *in situ*.

Emulsions of this kind are conveniently manufactured, using ordinary stirring vessels, by pouring the bitumen gradually, while stirring into warm water containing the alkali and emulsifying agent. If, however, a soft bitumen is employed, with a melting point below the boiling point of water, the warm water can be stirred into the molten bitumen to which the alkali and emulsifying agent have already been added. Bitumen in amount of about 50% of the liquid medium is usually sufficient.

The emulsifying agent should reach 1% or more. A solution of bitumen in a solvent is already dark and somewhat opaque when dry, even before incorporation of pigment, and in fact such solutions will stand pigmentation far more easily than bituminous emulsions. Excellent opacity can usually be obtained with one coat. The dry film is rather brittle unless plasticized with a material such as linseed oil or lanolin. Alternatively soft pitches such as stearin may be added. It is also necessary to add a matting agent, without which the water-sensitivity of these solutions is highly pronounced. To this end clays, drying oils, water-resistant resins and water-repellent greases may be added.

The most suitable bitumen for paint-making is gilsonite. A typical pre-war formula for paint of this description is cited as follows: Gilsonite, 30 lb.; stearine pitch, 15 lb.; naphtha, 3 gals.; turpentine, 12 gals.; white spirit, 5 gals.; linseed oil, 6 lb.; litharge, 4 lb.; rosin, 10 lb. H. B. M.

69.* Effect of Reinforcing Pigments on Rubber Hydrocarbons. F. S. Thornhill and W. R. Smith. *Industr. Engng Chem.*, 1942, **34**, 218.—The unsaturated values, percentages of combined sulphur in vulcanized rubber are correlated with stress–strain data, the curing time, and nature of the filler. From the data obtained it is concluded that whereas there is a loss of unsaturation in a stock containing non-reinforcing fillers, no such loss of unsaturation occurs in rubber compounds containing channel black. This alteration of the mechanism of sulphur vulcanization is mainly responsible for the different physical characteristics of reinforced rubber stocks. J. W. H.

70.* Industrial Progress in Synthetic Rubberlike Polymers. H. L. Cramer. *Industr. Engng Chem.*, 1942, **34**, 243.—The names and origin of some 20 different kinds of synthetic rubber, together with the methods of synthesis of the principal types, are given. The special properties and application of these synthetic rubbers are discussed and data are presented on the economics and U.S. production of synthetic rubber. J. W. H.

71.* Nitration of Methane. T. Boyd and H. B. Hass. *Industr. Engng Chem.*, 1942, **34**, 300.—The direct nitration of methane in the vapour phase over the temperature range 375–600° C., using 67% nitric acid has been investigated. The ideal conditions for this reaction involve the use of a 9 : 1 methane : nitric acid ratio at 475° C. at an exposure time of 0·18 sec. Under these conditions the conversion was 13% per pass. The activation energy of the reaction is 52 calories/mol. J. W. H.

72.* Vinylidene Chloride Polymers. W. C. Goggin and R. D. Lowry. *Industr. Engng Chem.*, 1942, **34**, 327.—The structure, properties, and application of this polymer are discussed and it is shown that these resins exhibit crystallinity, a property which enables unique fabrication techniques to be employed. J. W. H.

73.* Relation of Paint Properties to Surface Areas of Carbon Black. O. J. Brown and W. R. Smith. *Industr. Engng Chem.*, 1942, **34**, 352.—The total surface area of eight different carbon blacks have been measured by means of low-temperature nitrogen adsorption isotherms, and the surface area correlated with the intensity of blackness, volatile matter, p_H value, relative paste consistency, and the drying time when embodied in a suitable vehicle. It is shown that the carbon blacks with the largest surface area are the blackest, give stiffer and more viscous pastes, and result in longer drying times. J. W. H.

74.* Heat Capacity of Certain Halomethanes. G. Glockler and W. E. Edgell. *Industr. Engng Chem.*, 1942, **34**, 532.—The heat capacities of twenty-three halomethanes have been calculated by a semi-empirical method based on the contribution of bonds and angles to the molecular structure. These calculated values by this method, at three temperatures, are shown to agree to within 0·6% of the values calculated strictly in

accordance with statistical analysis of the Raman and infra-red spectrographic analyses. J. W. H.

75.* Activated Carbon from Hydrocarbons and Chlorine. G. W. Stratton and D. E. Winkler. *Industr. Engng Chem.*, 1942, **34** (5), 603.—A description is given of the production of an activated carbon by the controlled burning of propane or butane with the theoretical quantity of chlorine to form hydrochloric acid and carbon. The carbon can be activated by heating to 1000° C. for 90 min., and the product is shown to be superior to commercially available carbons for the decolorization of sugar, absorption of propane, chlorine, phenol, and iodine. By treating the carbon in an atmosphere of natural gas for 35 min. at 600° C. a carbon black for use in the rubber industry is formed which is superior to channel black. J. W. H.

76.* Swelling of Synthetic Rubbers in Mineral Oils. P. O. Poweres and H. O. Robinson. *Industr. Engng Chem.*, 1942, **34** (5), 614.—The aniline point of an oil is a reliable index of the amount of swelling which will take place in a synthetic rubber in contact with mineral oil. The lower the aniline point, the greater the swelling. The addition of polyolefines to mineral oils reduces this tendency to cause swelling. J. W. H.

77. Patents on Special Products. Bakelite, Ltd. E.P. 548,220, 1.10.42. Appl. 29.3.40. Preparation of an electrical insulating material which comprises a copolymer of a vinyl halide and a vinyl ester of a lower aliphatic acid, a flame-resistant plasticizer, an agent acting as a flux for the composition, and a mineral or vegetable wax, a mineral oil, a fatty acid or soap, the copolymer having an average molecular weight of between 8000 and 18,000.

C. H. Angell. U.S.P. 2,298,330, 13.10.42. Appl. 23.10.42. More valuable products are obtained from a hydrocarbon mixture containing olefins and paraffins of two, three, and four carbon atoms to the molecule by fractionating the mixture to separate from it a C_2 fraction, a C_3 fraction, and a C_4 fraction. The C_4 fraction is subjected to selective polymerization to polymerize the *iso*butene. Unpolymerized normal butenes and butanes from this process are mixed with the C_3 fraction and the whole subjected to polymerization to polymerize normal butenes and propene. From the residual gaseous products of this polymerization a C_4 fraction is separated containing *iso*butane, which is mixed with the C_2 fraction. The mixture thus formed is alkylated to react ethylene with *iso*butane.

A. Holmes. U.S.P. 2,298,793, 13.10.42. Appl. 1.7.39. A bituminous paint suitable for use as a protective coating to metallic surfaces consists of a cracking coil tar of 119–120° F. softening point. To obtain this a petroleum oil having a gravity of 30–35° F. A.P.I. is subjected to a temperature between 800° and 1000° F. at a pressure of 6–2000 lb. per square inch in a narrow, confined stream. Afterwards the heated oil is introduced into an enlarged container and the cracking coil tar is separated from it.

A. J. Van Peski. U.S.P. 2,299,716, 20.10.42. Appl. 11.5.40. *cyclo*Hexane is produced from naphthenic distillates by separating therefrom by fractional distillation a fraction boiling up to 75–78° C. and containing paraffin hydrocarbons and naphthenic hydrocarbons of non-hydroaromatic character having substantially equal boiling points. This fraction is treated at a temperature below 200° C. in the liquid phase under isomerization conditions with an aluminium chloride-hydrocarbon complex catalyst. *cyclo*Hexane is recovered from the isomerized distillate by fractional distillation. H. B. M.

Detonation and Engines.

78.* Mollier Diagrams for Theoretical Alcohol–Air and Octane–Water–Air Mixtures. R. Weibe, J. F. Shultg, and J. C. Porter. *Industr. Engng Chem.*, 1942, **34**, 575.—Theoretical data are presented for the above systems, and it is shown that the high latent of vaporization of the alcohol is of practical value, since it lowers the mixture temperature, and this is particularly important in supercharger operations. It is, however, pointed out that thermodynamic data of this type may assist in solving the problem of detonation or that of preignition, but its primary function was the analysis of kinetics and local temperature distribution questions. J. W. H.

Coal and Shale.

79.* Review of the Latest Developments and of the Possible Applications of High Pressure in the Motor Fuel Industry. Trans. from *Izvestiya Akademii Nank S.S.S.R. Otdelome Khimicheskikh Nank.*, 1940, No. 6, by I. B. Rapoport. *Foreign Petrol. Techn.*, Jan.–Feb. 1942, **10** (1/2), 1–6.—The paper gives a general account of the development of the process of destructive hydrogenation of coal in Europe and America. In Germany particularly, production of motor fuels by this method has rapidly increased, owing to the fact that at the outbreak of war stocks of crude oil in that country were not great. In 1939 Germany actually produced 1,500,000 tons of motor fuels in this way. It is interesting to note also that present plants in Germany are operated at a pressure of up to 700 atmospheres, as compared with the first plant, which was operated at 200–250 atmospheres. The explanation would seem to be that the degree of conversion of brown coal into liquid products depends on the chemical composition and age of the coal. Certain coals are incompletely liquefied at a pressure of 200 atmospheres. An increase in pressure has a beneficial effect on liquefaction, and at the same time allows the use of simpler and cheaper catalysts.

Yield in the vapour phase fluctuates considerably, and is dependent on the catalyst used. Data on catalysts used in the United States and in the State High-Pressure Chemical Institute (Leningrad) show that a slightly higher yield is obtained in Russia (0·87–2·24 vols. per volume of catalyst per hour) than in the U.S.

Studies have been made of the influence of the catalyst and of the raw material on the fuel obtained. Gasoline obtained from the products of thermal decomposition of mineral fuel and coal has a high octane number.

It is suggested that search should be made for more types of coal suitable for hydrogenation in the light of information now available concerning the use of greater pressure and the use of cheaper catalysts. The possibility of using pressures up to 1500 atmospheres should be checked forthwith. This will involve investigation of the physical-chemical constants of products and a special study of steel, armature, weldings, and recording instruments to be used. H. B. M.

80.* The Relation Between Calorific Values and the Road Performance of Producer Gas Vehicles. H. Webster, S. Bairstow, and W. A. Macfarlane. *J. Inst. Fuel*, February 1942, **15** (82), 93.—It has long been recognized that there should be a close relationship between the calorific value of a producer gas and the power developed by an engine, although some of the results which have been obtained from trials have been anomalous.

To examine this relationship, tests have been carried out on a Dennis lorry with a 2-ton load, a Mark Vc Government Emergency Producer, and " milk-churn " filter containing sisal being mounted behind the driver's cab. Each test consisted of a journey of 97·4 miles, care being taken to choose a route on which traffic variations were unlikely to occur. Anthracite, wood charcoals, and a number of representative low-, medium-, and high-temperature cokes were used as fuels, moisture contents ranging from 2·8–14·0%, ashes varying from 2·3 to 10·7% wt. on the dry fuels and calorific values covering a range of 12,700 to 14,650 B.Th.U. per lb.

In tests without extra ignition advance, anthracite and a low-temperature coke with a high content of volatile matter gave the best performances, followed closely by wood charcoal. Three medium-temperature cokes gave performances varying from good to so poor that the whole journey could not be completed. With extra ignition advance, anthracite and charcoal were still the best fuels, but under these conditions differences between fuels were minimized.

In discussing the results obtained it is pointed out that the effect of the moisture content of the gas reaching the engine is that of a diluent such as nitrogen and the amount of such dilution is one explanation of the observed discrepancies between calorific value and engine performance. Again temperature and pressure of the gas have a great effect on the calorific value and the fuels which give the best performance are those delivering gas to the engine at the lowest temperature.

It is concluded that when due attention is paid to these variables, the expected proportionality between gas quality and performance is revealed. D. L. S.

BOOK REVIEW.

Beitrag zur Kenntnis der Schmieröle und Triebstoffe für Dieselmotoren. By H. Stäger and H. Künzler. Institute of Technical Physics, Zürich.

This article is a reprint (20 pages) from *Schweizer Archiv für Wissenschaft und Technik*, 1942, **8** (8), and gives an account of the continuation of the authors' researches dealing with the changes which occur in fuel and lubricating oils during use in engines.

In the authors' opinion, new methods of examination of used oils are required because correlation between laboratory and engine tests have hitherto been unsatisfactory, especially because the insoluble residue formed in lubricants as a result of heating and oxidation has not been sufficiently investigated. In addition, it is unknown whether lubricant or fuel or both are responsible for deterioration, and the conclusions reached are therefore frequently erroneous.

For their investigation, the authors have used four oils—one of paraffinic nature, one naphthenic, one of mixed base—predominantly naphthenic, and one inhibited naphthenic oil.

The apparatus employed comprised two polished steel strips (2 mm. apart) between which the oil under test was circulated, the speed of flow being controlled by the angle of inclination of the strips. The latter were arranged to be electrically heated at a constant rate or at a constant temperature.

On the completion of each experiment the residue adhering to the steel strips was examined by a process of solvent extraction and the used oil was subjected to a variety of tests.

Of the conclusions to be reached from the results of the work some of the most illuminating are those which refer to the fundamental differences between the behaviours of naphthenic and paraffinic oils. It is shown, for example, that the paraffinic-oil residue contains more hydroxyl and carboxyl groups than the naphthenic oil residue, that the used naphthenic and mixed-base oils have smaller oxygen contents than the paraffinic oil, and that in some respects the mixed-base oils show no definite characteristics of either component.

The authors observe that the so-called hard asphalt which is normally precipitated with petroleum ether is not truly asphaltic in character but is a highly oxidized product which happens to be insoluble in this particular solvent. It is considered, furthermore, that these types of residues may be misleading when judged by normal characteristics.

The work has obviously not yet attained any degree of finality, and it is not out of place to stress that the object of the work was to study the changes which take place in an oil during use in an engine. Thus, all work of this nature should eventually be paralleled by engine tests, and the conditions employed in the laboratory experiments should preferably not differ widely from those of the engine when working, otherwise the conclusions reached from laboratory work may not be applicable to engine conditions. One of the most essential present-day objects of all such work is to devise some method of laboratory test which would at least grade the oils in the same order of performance as that indicated by the engine.

W. H. Thomas.

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Geology and Development.

81.* Development in Oklahoma during 1941. J. L. Borden. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1058.—After declining since 1937, Oklahoma's total production rose in 1941 by 2½ million brl. to 152 million brl., or 10·9% of the total for the U.S.A. Estimated reserves have also increased to 1036 million brl. The chief areas of new oil and augmented production are in the south and south-west. In the northern part of the State increases have been chiefly obtained by reconditioning wells and by deeper drilling. As a whole the central countries have declined.

Discoveries of forty-one new pools were made, of which Apache, in Caddo County, is the most important. A 3433-ft. well was completed in September 1941 in Simpson sand (Middle Ordovician), which flowed 1466 brl. of oil—39·2° gravity corrected—in twenty-four hours, and about 3 million cu. ft. gas. Gas is also encountered in higher formations—viz., Sylvan dolomite and Viola limestone (Ordovician)—and its control presents problems, but it will be valuable in repressuring and in gas-recycling when the Simpson gas falls off. A seismographical survey discovered this trap, which is in the form of an asymmetrical fold, probably overturned.

The 40-acre spacing rule may somewhat curtail Oklahoma production. A. L.

82.* Developments in North Mid-Continent in 1941. E. A. Koester. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1073.—Kansas produced 83,229,159 brl. crude oil in 1941, compared with 64,824,721 brl. in 1940—an increase of 28%. Output was speeded up with ease as pipeline facilities were made available.

Heightened activity in wildcats caused an increase in the percentage of dry holes from 20·3 in 1940 to 26·9 in 1941, in which year 1253 oil-wells, 75 gas-wells, and 490 dry holes were completed.

The chief discovery was commercial production from a sand in the Cherokee (Lower Pennsylvanian) at a depth of 4740–4752 ft. in the Patterson pool, Kearny County, Kansas. Initial output was 3000 brl./day. This opens up hopes of similar productive areas in western Kansas and in eastern Colorado.

An important group of pools has been found in the Viola limestone (Ordovician), along the Peace Creek trend in south-west Reno County. Eighteen wells completed in 1941 had a potential of 48,879 brl. These pools are north-east of the Zenith pool, which they resemble. New pools on the Central Kansas uplift are relatively unimportant. In north-west Kansas the Ray pool is successful. Development of the McLouth pool, Forest City basin, continued.

A "pay" was found at depth in the Hunton dolomite (Siluro-Devonian) of Falls City pool, Richardson County, Nebraska. In the same county the Barada pool has

been drilled in an equivalent dolomite which was topped at 2432 ft. Productive capacity is the same in both, but the Barada producing area may be small.

Six dry holes each, in Missouri and Iowa, showed small promise. No wells were drilled in South Dakota, but exploration goes on. Low crude-oil prices discouraged wildcatting in these three States. A. L.

83.* Developments in Eastern Interior Basin in 1941. A. H. Bell. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1086.—In 1941, 3838 wells were drilled in Illinois, more than in any year except 1907. In spite of a rise in south-western Indiana from 450 (1940) to 463 wells, the decrease in drilling in western Kentucky left the total of 4651 completed wells in the Eastern Interior Basin somewhat lower than the figure of 4680 for 1940.

In the deep basin of the lower Wabash River forty-four new pools and forty-three extensions were discovered. None of these is of major importance, however, and the production of the whole Basin was 145,603,000 brl., showing a decline of 6% since 1940. The percentage of the U.S.A. total was 10·3%.

In Illinois most of the new discoveries were in Chester sands (Upper Mississippian) and in the Iowa Series (Lower Mississippian). 91·5% of the year's yield was from Mississippian. Many deep tests were sunk to Devonian—one discovery—and "Trenton" (Ordovician)—no discovery. Production from Devonian limestone has fallen from 26% of the Illinois total in 1940 to 6% in 1941. Ordovician production stands at 0·9%. Pennsylvanian—three discoveries—yields 1·7%.

The "Niagara" or Lower Silurian of eastern Indiana has produced some gas in Pulaski County.

In western Kentucky the shallow depths at which Chester occurs are attractive to "small business". At no great depth Devonian and Silurian also offer an enticing speculation. But as the Knox dolomite (Ordovician) has yielded no showings of oil or gas, little interest is being taken in deeper drilling. A. L.

84.* Oil and Gas Developments in Michigan during 1941. R. P. Grant. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1097.—The number of wells completed decreased from 1181 in 1940 to 951 in 1941, and the number of feet drilled from 2,304,855 to 2,002,341. The reduction is due to shift of interest from the shallow district of south-west Michigan to the deeper part of the Basin area. The total production was 16,358,717 brl., approximately 17% below 1940. Sixteen oil and gas discoveries and major extensions were made.

In the Basin, development is notable in the Reed City field, western Osceola County. This field taps the Detroit River pay (Devonian), which gave an initial flow, under natural conditions, of 1900 brl./day. By December 1941 the field was yielding 18,610 brl./day from 3000 acres. The structure trends from north-west to south-east, aud has steep dips on either flank. Other pays are in the Traverse and Dundee formations. In the same area "Michigan Stray" (Mississippian) gas fields are also expanding.

In south-western Michigan the most important find was the West Hopkins field, Allegan County, producing oil from the Traverse limestone (Devonian). By the end of 1941, from about 500 acres, nineteen wells were giving 1435 brl./day. A. L.

85.* Developments in the Appalachian Area during 1941. Appalachian Geological Society. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1110. *New York.*—Of forty-one wells completed in the Oriskany (Devonian) sand area of southern New York, twenty-one were dry and twenty have a combined open flow of 98,508,000 cu. ft. No new areas were found, and production is on the downgrade. Wildcats to Oriskany, in Allegheny County, found dry sand, or salt water, or missed the sand.

Pennsylvania.—More than at any time during the past decade, attention was focused on the gas territory with shallow sands in western Pennsylvania. Old pools have been extended and new pools have been located, including the Armbrust pool, Westmoreland County, producing from Fifth Sand (Upper Devonian) over an area of more than 600 acres. Open flows up to 5 million cu. ft./day have been obtained in the Big Injun sand (Mississippian), in Fayette and Greene Counties. Successful deep drilling was practically confined to the Summit gas pool (Devonian), Fayette County. Production in Pennsylvania fell 3·5% from 1940.

Ohio.—333, 21% out of 1561 holes drilled, produced oil, 701 or 45% produced gas, and 527 or 34% were abortive. The total production was 3,547,534 brl. from 24,801 oil-wells. This represents an increase over the 1940 figure of ½ million brl., practically all of Pennsylvania grade, and principally due to new flowing wells in the Clinton sand (Silurian) in Perry County. Natural gas yield for 1940 (hitherto unpublished) was 40,369 million cu. ft. from about 7000 wells—*viz.*, half of the maximum reached in 1915. New Clinton gas wells have proved of importance. Good results have been obtained by flooding the Berea (basal Mississippian) in Medina County, where the sand lies at an average depth of 475 ft.

West Virginia.—182 wells were drilled to or through the Oriskany; 166 gave a combined open flow of 764½ million cu. ft. and sixteen were uneconomic. Tests of the Silurian in the Elk-Poca field and in Boone County were fruitless.

East Kentucky.—Of 422 wells sunk in 1941, sixty were dry, 259 gave gas with open flow of roughly 117 million cu. ft./day, and 103 had an initial production of 903 brl. Producing horizons range from the Salt sand (Pennsylvanian) down to the Knox dolomite (Cambro-Ordovician).

East Tennessee.—Nine wells, totalling 13,705 ft., east of the Cincinnati arch, had possibly significant showings.

Maryland.—One well in western Panhandle, at 8096 ft., showed gas and salt water in the Oriskany.

Virginia.—Two wells were drilled to Devonian shale, one dry, one with some gas.

A. I.

86.* Californian Exploration and Development in 1941. J. R. Dorrance. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1135.—The decline in new discoveries has been checked. Eight entirely new fields—one a gas field—have been established; and five other areas may be new, or connected with old fields. In 1941, 101 wildcat wells were drilled, as against seventy-eight in 1940. Geophysical parties at work increased from sixteen to twenty-five.

Wilmington and Coalinga were first and second as the most active fields, with the Santa Maria Valley field replacing Coles Levee in having the third largest number of holes completed in 1941.

A production of 230 million brl. was the biggest during the past ten years except for the flush period of 1937–38. Many of the new discovery wells have had an initial flow from Miocene or Pliocene horizons of up to several hundred brl./day. Unfortunately the reserves in the newly found fields are disappointing—only equal to a tenth of a year's production.

The discoveries at Raisin City, and those in the Helm and Riverdale fields, are important, since they prove the extension of oil occurrence northwards in the San Joaquin valley. The Helm well assures of productive Eocene beds beyond the bounds of the Gatchell pool, near Coalinga.

Among significant extensions are the following :—

(1) In the Paloma field, Kern County, 90–125 ft. of B-12 sand, yielding an initial flow of 575 brl./day, have been found above the Paloma producing zone. This sand seems to have the form of an open umbrella with the centre of the cover cut away.

(2) In the Inglewood field, Los Angeles County, on the northern outskirts of the old Pliocene pool, the Smith Well No. 1, produced 2000 brl. gross/day, of 31·1° gravity through a 1¼-in. choke, accompanied by 2,300,000 cu. ft. gas. This came from roughly 170 ft. of sand in a 413-ft. zone of the Middle Miocene (mainly of *Valvulineria californica* horizon). Pressure may exceed usual hydrostatic pressure. Sixteen producing wells completed by December showed a total sand thickness averaging 125 ft.

(3) The Del Valle field, discovered in 1940, has been extended to produce from the Modelo series (Uppermost Miocene), 1½ ml. west of the original area. Accumulation is probably owing to lenticularity and faults.

(4) New deep zones have been found in the Oak Canyon field (Lechler zone), at 6905 ft.

(5) Two sub-commercial zones, at depths of 8275–10,075 ft., with saturated sands, too tight to be profitable, have been found both in the Ventura Basin.

The larger anticlines have been well examined; and attention is now turning to study faults for closures and to reconstruct coastlines, etc., for stratigraphical traps. There is a growing need—and a more aggressive search—for gas, especially in gas regions of the central and northern valleys. A. L.

87.* Graphic Method for Some Geologic Calculations. M. L. Hill. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1155.—A graph with quadrant arcs on rectangular co-ordinate paper is supplied on which, with the help of protractor, set-square, compass, and scale, solutions can be quickly arrived at in finding thickness of a bed, given depth and width of outcrop; in finding depth, given thickness and dip; in finding dip, given depth and width of outcrop; and in other problems concerning dip, depth, width of outcrop, and thickness, where two of these are given and a third must be found.

Graphical methods eliminate the gross errors which sometimes originate from hasty trigonometry.

The graph can be used in "three point" problems. A. L.

88.* Artificial Horizon and Geological Perspective. E. W. Owen. *Bull. Amer. Ass. Petrol. Geol.*, July 1942, **26** (7), 1185.—War is the "datum plane" for immediate geological planning. The qualities of a good oil-finder are the same as those of a good army man—visualizing a countryside from maps, flexible mentality, diverse training. It is expected that up to 50% of the membership of the A.A.P.G. will enter the forces. At present a surplus of oil is available, but with the expansion of the fighting services and corresponding demand for oil, new exploration and development will become urgent within two years.

War conditions and regulations are a threat especially to the financial position of independent operators who make up one-third of the members of the A.A.P.G. These "small men" have made most of the discoveries in the past, and their independence must be defended. A. L.

89.* Neglected Gulf Coast Tertiary Microfossils. H. M. Howe. *Bull. Amer. Ass. Petrol. Geol.*, July 1942, **26** (7), 1188.—To-day, eastward from the Mississippi delta terrigenous sediments rapidly diminish, while fine clays, limestones, and chalks increase. This was also true during the Eocene and Oligocene, when the less muddy environments favoured the larger Foraminifera and other groups seldom encountered in the area west of the Mississippi.

Ophiurans—brittle stars—are very common under certain environmental conditions upon modern sea-floors; and eighty living species have been described from the Gulf region. Very few records have been made, but their armbones are important in the earlier Tertiary of the south-eastern United States.

Only a few Tertiary crinoids have been described, though A. H. Clark's great "Monograph of Existing Crinoids" (1915–41) is available to help in classifying and describing them. The unstalked "free-swimming" comatulids are not so rare in the Tertiary as Springer suggested in 1925. Howe records their ossicles from the Salt Mountain limestone and Princetown sand (Lower Eocene) and other horizons up to the Vicksburg (Oligocene).

Marginal plates, variously ornamented, with a row or rows of nodes, or a spine, serve for the identification of different starfishes at a number of horizons up to the Choctawhatchee (Miocene) at Jackson Bluff, Florida.

Holothurian—sea-cucumber—remains are also common enough.

Restricted to the Vicksburg (Oligocene), the bryozoan *Enoplostomella* appears to give rise to definite species at certain horizons, and the genus *Bactridium* can be used in much the same way in the Jackson (Eocene). "Acorn" and "goose" barnacles, occurring as separated plates, Crustacea, and marine diatoms—all abundant in many places—should all be useful in stratigraphy. A. L.

90.* How can Geophysicists best serve? H. B. Peacock. *Bull. Amer. Ass. Petrol. Geol.*, July 1942, **26** (7), 1200.—How essential are new discoveries of oil? From discussions of proration and allowables, people seem to think production can be doubled or trebled. But the fact is that such increases would greatly decrease ultimate amounts recovered and production would the more rapidly decline. Reserves in the

U.S.A. as at 1st January, 1942, have been estimated at 19,586 million brl. Output for 1941 was 1404 million brl. Possibly we have almost fourteen years' supply on hand. The optimum supply would, however, only be obtained in many cases if production could be stretched over twenty-five or more years.

The loss of the East Indies means greater demands on American oil. The Petroleum Co-ordinator expected that 3,600,000 brl./day would be needed in 1942, or almost the same production as in 1941, and the demand will increase. The Government has called for up to 5000 wildcats to be drilled in 1942. This must surely imply increasing exploration.

For the three years 1938–41, of wildcat wells sunk on geological advice, 4631 were dry and 825 productive, *i.e.*, 1 in 6·6; on geophysical advice 1535 were dry and 390 were productive, *i.e.*, 1 in 4·9; on joint geological and geophysical advice 301 were dry and 94 productive, *i.e.*, 1 in 4·2. This raises geophysical hopes, and suggests more co-operation between geology and geophysics. Of non-technical holes 3554 were dry and 199 productive, or only 1 in 18·9.

Of all geophysical methods, that of the reflection seismograph offers greatest opportunity of benefit, from detailed study of fault patterns and structural variation at depth. This provides a check on the continuity of geological observations obtained from wells. Geochemical and fluorographic methods have their appeal in locating stratigraphical accumulations, "but until more effective techniques for finding stratigraphic traps" are discovered, we must continue to seek the tectonic type.

It would be dangerous for the United Nations if the numbers of geophysical personnel suffered serious reduction. A. L.

91.* Good Geologists make Good Neighbours. W. E. Pratt. *Bull. Amer. Ass. Petrol. Geol.*, July 1942, **26** (7), 1207.—Supporting the Good Neighbour Policy for a Commonwealth of the Western Hemisphere, W. E. Pratt, Standard Oil Co. of New Jersey, predicts the development of oil in Latin America by United States technicians and finance. What the South American republics require is a working class. "In the American method of oil-finding the scientist is a workman and the workman becomes a scientist. . . . The technique is peculiarly American, born of free enterprise and the dignity of labour." A. L.

92.* Problem of Exploration. E. de Golyer. *Bull. Amer. Ass. Petrol. Geol.*, July 1942, **26** (7), 1214.—The American Petroleum Institute's estimate of U.S. reserves in 1938 was a little over 21 billion brl. At the beginning of 1942 it was somewhat under 20 billion. For the past three years, 1939–41, the average number of fields discovered was exactly double the average annual discovery rate for the previous five years, 1934–38. But the estimated average reserve in each field in the earlier period was 15·6 million brl., whereas in the second period it was only 1·18 million brl. The estimated reserves discovered annually have fallen from 1900 million brl. in 1937 to 400 million in 1941. This is not comforting.

The intensity of wildcatting and prospecting depends on (1) price of oil and the prosperity of the oil industry, (2) availability of land suitable for prospecting, and (3) degree of exhaustion of current prospecting techniques.

Successive exploratory methods have come in slowly, been accepted, reached a peak rapidly, and have then declined to relative unimportance. "A technique exhausts itself by being used." Pemberton says that with the discovery of the Casmalia field, California, in 1904, the technique of drilling near seepages, which had given thirty-two discoveries, was at the end of its usefulness. Subsequent discoveries up to 1936—sixty-eight in all, and seven in addition from 1936 to 1939—were due to purely geological techniques. From 1936 to 1939 there were thirteen fields discovered by geophysical exploration.

On the Gulf Coast from 1901 to 1924, the technique in vogue was to find seeps and/or topographical mounds. From then until 1932 the discoveries were mostly geophysical by means of torsion-balance or refraction seismograph. Now, as in 1924, we are faced by the exhaustion of prospecting methods as far as the Gulf Coast is concerned, since refraction surveying has now covered the area, and some parts have been examined six or seven times by competing interests.

For Oklahoma the earliest technique was clinometer surveying; about 1912 plane-table mapping of the surface geology came in, and was a derelict method by the middle

'twenties. Core-drilling was the next specific technique, supplemented about 1930 by correlation reflections.

The task is to find new exploratory methods—one is the palæogeography of coastlines—as well as new fields. A. L.

93.* Geology in War and Peace. Carey Croneis. *Bull. Amer. Ass. Petrol. Geol.*, July 1942, **26** (7), 1221.—Hugh Miller sixty years ago was a popular author. Allowing for later increase in the numbers of those who read, it may be said that at least three of his geological books had a circulation greater than that of *Gone with the Wind !* Since 1919 his name has been deleted from most of the encyclopædias. That is a true index of the decline in status of the Science of Geology. In literature, in national administration, in the effort of war, in salaries, geologists are stepchildren.

There is still a public demand for geological information, and much of geology is readily comprehensible by the lay mind. Nevertheless the more abstruse aspects of physics, chemistry, and biology command fifty times as much space in the Press. Since the passing of the elder Geikie, geologists have been much too self-effacing. The Geological Societies of America and London have adhered too closely to an exclusive professional etiquette, and have actively avoided publicity among the generality of people.

The tendency of individuals to call themselves mineralogists, geophysicists, and palæontologists, instead of plain geologists, has also been an adverse influence. One result is that the geological profession, and the advice they give, are increasingly neglected, except in the oilfields. On one aerodrome site alone in Britain, to mention no others, £500,000 was lost through the ignoring of geological advice. The same kind of thing will certainly happen in America, unless geologists, like other scientists, assert the value of their work.

An American Geological Association to include 10,000 geologists from the Western Hemisphere is suggested. This would publish and propagate geological news, would arrange for rewards to geological workers in different age groups, instead of keeping these in the main for the semi-superannuated, and would maintain public relations committees on topical subjects. It would be supremely important to try to raise the standard of the recruits to the profession, and also to work for improvement of the educational opportunities of geological students. In fourteen groups of post-graduate students, arranged according to subjects of study, the geological researchers, in tests of general education, have been found to occupy only sixth place. They were graded below the students doing research in Physics, Moral Philosophy, Mathematics, Chemistry, and Psychology !

The Japanese expansion in the East Indies was evidently planned on a basis of the geological resources required by them ; and it is criminal folly for the United Nations not to be fully advised upon what must be held at all costs. A remarkable suggestion is quoted for bombing of major fault-lines in Japan to hasten the next great earthquake, " which, on a periodicity basis, is due sometime in the next few years." A. L.

94.* Developments in North Louisiana and South Arkansas in 1941. B. W. Blanpied and R. T. Hazzard. *Bull. Amer. Ass. Petrol. Geol.*, July 1942, **26** (7), 1250.—A production of about 53 million brl. in 1941 was almost equally distributed between North Louisiana and South Arkansas. In the former, 798 wells were drilled, and in the latter 207. Of the total 564 were oil-wells, 123 obtained gas and gas-distillate, and 157 were dry.

In South Arkansas, Hosston—" Travis Peak "—oil (Lower Cretaceous) was discovered in the Smart Sand area of Stephens field, Columbia County ; Cotton Valley oil (Jurassic) in East Schuler field, Union County ; and Smackover Limestone oil (Jurassic) in two fields—Mount Holly, Union County, and Patton field, Lafayette County.

In La Salle Parish and Catahoula Parish, North Louisiana, six new fields were discovered. In Haynesville field Claiborne Parish, the Pettit limestone (Lower Cretaceous) at 5431–5440 ft. yielded an initial 227 brl./day of 38·7° gravity oil after being acidized through gun perforations ; the gas–oil ratio was 269 to 1. Jurassic gas-distillate pools were also found in the same Parish. Yield from Smackover limestone, in the North Lisbon field, Claiborne Parish, is so far the only oil from this horizon in North Louisiana. The gas-oil ratio is 9900 to 1. A. L.

95.* Midway Field Discovery, Lafayette County, Arkansas. E. A. Markley and C. N. Valerius. *Bull. Amer. Ass. Petrol. Geol.*, July 1942, **26** (7), 1289.—Hitherto the whole production of the Smackover limestone (Jurassic) has been from the topmost member—the Reynolds Oolitic zone. In addition to this the Bond well has found an entirely new producing zone of 118 ft. of granular, almost completely non-oolitic limestone at 65 ft. below the Reynolds zone.

The Bond well produces sweet gas with only 1·42% by weight of high-boiling point sulphur compound. This is non-corrosive, unlike the sour oil and gas from the Smackover in other parts of Arkansas, which has much sulphur of a corrosive nature.

The anticlinal axis of the Midway field trends from north-west to south-east, and is more steeply folded than most Smackover producing structures. A. L.

96.* Oilfield Waters of Montana Plains. J. G. Crawford. *Bull. Amer. Ass. Petrol. Geol.*, August 1942, **26** (8), 1317.—The identification of strata by means of their contained waters is becoming a possible procedure throughout the Rocky Mountain States. In this region, oilfield waters are much less concentrated than elsewhere, and if concentrations exceed 2000 parts per million total solids, commercial pools are possible and probable. In general the lower concentrations indicate water-movement which may have swept oil away, but in some cases dilute artesian water has been forced upwards through faults and fractures, and so has been trapped with oil. Average waters of Montana oilfields have 1500–15,000 p.p.m. of solids. Almost all contain a small amount of calcium and magnesium, but these radicles are not prominent above the "Quadrant" (Upper Mississippian and Lower Pennsylvanian). This appears to be due to the softening of action of bentonite layers which remove calcium and magnesium by base-exchange. In the "Quadrant" and below it, calcium and magnesium are prominent.

The first important oilfield waters are those of the Montana group (Upper Cretaceous), with fairly dilute solutions of sodium salts. Sodium sulphate prevails where surface waters have access to the sands, but deeper waters associated with gas are moderately concentrated, and contain sodium chloride. Where secondary characteristics are present the ratio of magnesium to calcium may be greater than unity. Sands in the Colorado shale (Upper Cretaceous) have small quantities of water, of higher salinity than waters of the Montana group. This is due to tightly packed grains retaining connate water.

Salt-and-pepper sands of the Kootenai formation (Lower Cretaceous) are important oil- and gas-producers in the Border-Red Coulee, Cutbank, and Kevin-Sunburst fields. Where associated with gas, the waters are fairly concentrated with sodium chloride and sodium bicarbonate, which are present in proportions found to be characteristic of the different sands.

The Ellis formation (Upper Jurassic) of black organic limestone and black shale with sand yields sulphur-bearing gas—not commercially produced—in the area of the northern Sweetgrass arch. Oil is obtained from the Ellis-Madison contact in the Kevin-Sunburst field. Ellis waters are moderately concentrated with sodium chloride and sodium bicarbonate; alkalinity is greater than salinity; 0–20% calcium and magnesium bicarbonates, appreciable hydrogen sulphide, and some sulphate are present.

"Quadrant" rocks comprise marine and non-marine red and black shales, cherty limestone, and sandstone. The waters contain large quantities of sulphates of calcium and magnesium. The bicarbonate content is low. The Tensleep sandstone (Pennsylvanian) of southern Montana yields similar waters. These are often hot. Flows may reach 125,000 brl./day.

The Madison limestone (Lower Mississippian) has not been fully explored by wells. Although unproduced oil has been discovered below it in the Cedar Creek anticline, the Madison is the oldest commercial source of oil and gas in Montana. It has two types of water. The first are solutions of sodium salts, with chloride and bicarbonate as the dominant negative radicles, and with appreciable alkaline earths and sulphur. They are found in the Sweetgrass arch, and have been affected by the acidization of wells. The second type consists of solutions of calcium and magnesium sulphate, with only moderate amounts of chloride and bicarbonate radicles, as in the north-central and central fields.

The oilfield waters of Montana resemble those of Wyoming, but are less concentrated on the whole. Migration of water from one formation to another may well

be the explanation of Cosmos-Vanalta (Lower Cretaceous) water with hydrogen sulphide probably derived from the underlying Ellis. A. L.

97.* Late Palæozoic Stratigraphy of Gore Area, Colorado. K. G. Brill. *Bull. Amer. Ass. Petrol. Geol.*, August 1942, **26** (8), 1375.—This area of 350 sq. ml. in Eagle and Summit Counties, 120 ml. west of Denver, contains an asymmetrical syncline of strata of Upper Cambrian to late Palæozoic age. On the south-west side the dip off pre-Cambrian gneisses of the Sawatch range is at an average of 25°, and on the north-east faults bring up the pre-Cambrian of the Gore and Tenmile ranges.

The pre-Pennsylvanian systems are Sawatch quartzite (Upper Cambrian), Manitou limestone (Ordovician), Harding sandstone ((Middle Ordovician), Chaffee formation (Upper Devonian) comprising quartzite and dolomite, and Leadville limestone (Mississippian). Outcrops of these are practically confined to the south-west side of the Eagle valley; and westward thinning of the Leadville guggests that it may not have been deposited much farther west than the present outcrops.

The Pennsylvanian succeeds unconformably. The Battle Mountain formation, 4300 ft. in the north to 7900 ft. in the south, is mainly of grits and sandstones, but has some thick beds of shale and conglomerate. There are occasional limestones and dolomites ranging from a few inches to 30 ft. thick. Fossils are marine: worms, gastropods, brachiopods, corals. At the base 100–200 ft. of Belden shale—heretofore called Weber shale—rest on eroded Mississippian. Deposition took place during transgression from the south or south-east. Belden fossils in argillaceous limestone include *Orbiculoidea* cf. *capuliformis*, *Derbya* sp., *Paeckelmannia* sp. nov., *Chonetes* cf. *granulifera*, *Squamularia* sp., *Composita subtilita*, and poor lamellibranchs. Small beds of coal suggest swamp conditions and a mild climate on land. Above the Belden well-marked cycles of deposition (" cyclothems ") are noticeable, consisting of: (1) massive conglomeratic grit on irregular substratum; (2) thin-bedded sandstone; and (3) thin shale. Junctions of (1) with (2), and of (2) with (3) are gradational. A 3-inch Bentonitic ash with quartz, biotite, and shards, 950 ft. above the base of the Battle Mountain formation has been found at two localities, and marks the eastward limit of Pennsylvanian volcanism in the United States. The Robinson limestone member, 15 ft., with corals, *Marginifera* cf. *lasallensis*, and *Ambocoelia* sp., is useful in Turkey Creek (type section) and in the Pando-Jacque Mountain area, for correlation of the middle beds of the Battle Mountain. Near the top of the latter, the Jacque Mountain limestone, 18 ft., with *Schizodus* sp., *Bellerophon* cf. *crassa*, *Ephippioceras* sp., and intercalated breccias, also provides a datum plane for a wide territory. Ostracods from above the Robinson are assigned by Miss Hecht to a Marinaton age (Lower Pennsylvanian).

Above the Jacque Mountain member, the Battle Mountain clastics are a brilliant red, and in them macerated remains of the coniferous plant *Walchia* have been found. Still higher, *Marginifera muricatina* indicates a Des Moines age (Pennsylvanian). Evaporite beds of the Eagle gypsum basin interdigitate in the top of the Battle Mountain.

The State Bridge formation, about 500 ft., follows conformably upon the McCoy, or northern equivalent of the Battle Mountain. It is mainly of red and grey silts and shales, finer than those in the earlier formation, and presumably derived from ancestral Rockies of reduced dimensions. One calcareous sandstone, in association with algal limestone, yields the lamellibranchs *Myalina* sp., *Pleurophorus* sp., and *Aviculopecten* sp., which Newell thinks may be Middle or Upper Pennsylvanian—or even Permian.

Erosion of the State Bridge took place before deposition of the Upper Triassic. Further accumulation ensued in the Upper Jurassic and Upper Cretaceous.

In the Laramide orogeny the high-angle reversed faults along the Gore and Tenmile ranges were formed, and drag on the west sides produced the Gore syncline.

Porphyry sills were intruded in late Cretaceous (Denver) and in the early Cainozoic. In the Miocene, lavas were poured out. A. L.

8.* Subsurface Study of Ellenburger Formation in West Texas. T. Cole. *Bull. Amer. Ass. Petrol. Geol.*, August 1942, **26** (8), 1398.—The Ellenburger (Cambro-Ordovician) where penetrated in West Texas, consists of fine to coarsely crystalline dolomites and dense limestones, with secondary anhydrite, and some streaks of sand and shale. These units change laterally, so that for correlation—apart from faunal evidence from

which six zones may be distinguished corresponding with those recognized in Missouri —insoluble residues are of considerable value. The nature, rather than the actual percentage weight of the residue, is used; and the kind of chert fragments present forms the most important criterion. The four classes of chert are: smooth, granular, chalky, and drusy. The first three are diagnostic. Drusy chert may be quartz or a recrystallized form of one of the other types. Oocasts and dolocasts—spaces left after solution of oolites and dolomite crystals, respectively—are noted. By such means the 1335 ft. section of Ellenburger can be divided into five zones.

Plotting of the zones shows a truncated axis of folding parallel with the Permian folding (San Andres), which extends north-west and south-east rather than north and south. There is probable overlap of the base of the Ellenburger against the Apco Ridge, in Pecos county.

Since exploitation was begun in 1930 the Ellenburger of West Texas has yielded 30,000,000 brl. from twenty-four wells. A. L.

99.* Upper Pennsylvanian Anhydrite, West Texas. R. Roth. *Bull. Amer. Ass. Petrol. Geol.*, August 1942, **26** (8), 1412.—Anhydrite is not restricted to sediments of Permian and younger date. It has been found in the Cisco (Pennsylvanian) of West Texas. A. L.

100.* Stratigraphy of North Dakota. O. A. Seager *et al.* *Bull. Amer. Ass. Petrol. Geol.*, August 1942, **26** (8), 1414.—The authors supplement Dr. Kline's account (*Bull. A.A.P.G.*, March, 1942) with suggestions that Oligocene and Miocene strata of the White River group are more widespread than has been believed; that Sentinel Butte is Wasatch (Eocene), and Upper Wasatch is represented north of Hebron; that the Fort Union formation (Paleocene) has three members—Tongue River, Cannonball, and Ludlow, with the latter two interdigitating; that the Hell Creek formation is Upper Cretaceous; that Jurassic should be found under much of western and northern North Dakota; that redbed Triassic and Devonian are readily confused; that some of Dr. Kline's dubitable Cambrian may be Ordovician which possibly occurs in many parts of the State.

Data from Manitoba, Montana, and South Dakota, bearing on the stratigraphy of North Dakota, are liberally adduced. A. L.

101.* Well Spacing and Production Interference in West Columbia Field, Brazoria County, Texas. J. C. Miller. *Bull. Amer. Ass. Petrol. Geol.*, September 1942, **26** (9), 1441.—From its earliest deep development in 1917 until 1937, the West Columbia piercement saltdome field produced mainly from the basal Miocene sands. There was some oil from Oligocene sands, but the first commercial Oligocene well was drilled in 1937. To January 1941, the total yield was 80¼ million brl. The basal sands of the Miocene range from 500 ft. in thickness in the vicinity of the dome to 700 ft. on the flanks. The upper "A" zone (appr. 200 ft.) is fine to medium-grained with re-worked Cretaceous and indigenous marine fauna. The lower or "B" zone, separated from "A" by a shale layer (100–150 ft.), averages 200 ft. of medium-grained, well-graded, clean sand, with permeability varying from 2000 to 15,000 millidarcys. A still lower "C" zone (50–60 ft.) is medium to coarse-grained, not so well sorted, with abundant marine fauna.

Production has been sustained by natural water drive as is seen from the northern segment, west of the East Abrams fault, where a bottom-hole pressure estimated at 1330 lb. per sq. in., in 1920, had only fallen to 1104 lb., in 1935. Over the whole period, production remained at about 450,000 brl. of fluid/month. In flowing wells, however, where the percentage of water to oil increases, the weight of water adds to bottom-hole pressure, which, in turn, reduces the reservoir-pressure differential towards the well, and oil-flow falls.

At the reservoir temperature and pressure the normal saturation of the oil with gas would be 154 cu. ft./brl. The actual gas–oil ratio is 60 cu. ft./brl. This under-saturation was probably produced during regional submergence; only here and there has gas been liberated from solution owing to big withdrawals of oil. The gravity of the oil is low, 20–21° Bé. There is little shrinkage. No evidence exists of a former gas-cap.

Where wells are drilled too closely, or production is at a very rapid rate, drop in

pressure may be enough to change the type of drive from hydraulic to volumetric through liberation of gas. In the north-west segment of the field, although four times as many wells were sunk in sand "A" as in sand "B," the recovery, at a little over 1100 brl./acre foot, was roughly the same in each case. The wider spacing of 17·5 acres per well corresponds with a drainage radius of 492 ft. Fluorescein experiments in "A" sand showed a migration of fluid up dip amounting to 800 ft. in 180 days. Differential rates of withdrawal may even produce migration in down-dip directions.

When one new well was completed about 500 ft. up dip from an older one, the percentage of water produced from the latter increased sharply. The products of the two wells, however, when added together, showed that the increase of water continued at the same rate as in the case of the older well. Lateral interference can also be illustrated from wells 500 ft. apart on the same strike. The conclusion is that the field would have been properly drained under a wider spacing programme than that of 17·5 acres per well. A. L.

102.* Schuler Field, Union County, Arkansas. W. B. Weeks and C. W. Alexander. *Bull. Amer. Ass. Petrol. Geol.*, September 1942, **26** (9), 1467.—The Schuler field, discovered in 1937, lies west-south-west of El Dorado, Arkansas, and produces from lensing and basal sands of the Cotton Valley formation (late Jurassic to early Cretaceous ?) in a domal structure elongated from west-north-west to east-south-east. Production is also obtained from the Reynolds Oolite zone of the Smackover (Jurassic). In the latter the concentration of oil is anticlinal, and there is very evident water-drive. In the Cotton Valley there is little of this, owing to sealing by petroleum residue in the basal beds and lenticularity of sands higher up.

Production from the Smackover by July 1941 had reached 2,766,280 brl. from sixteen wells.

The Jones sand, about 65 ft., at the base of the Cotton Valley may be of sandbar origin with thickest accumulation in the Schuler area. The oil seems to be from the surrounding grey shale, but some may have migrated from the Smackover. Proved over 4000 acres, this sand between 1937 and 1941 produced 18,542,590 brl. from 146 wells. Initially the gas–oil ratios were from 500 to 1200 cu. ft./brl., but by June 1940 they were from 400 to 10,163/1.

The Leona sand is being developed. It had three wells at the end of 1941.

The Morgan zone, 500 ft., with lenticular sands has an upper part containing grey and maroon shales, while the lower part is more definitely redbed. Red sands and shales—apparently non-marine—predominate down to near the top of the Jones sand. They are without oil. There is some lignite in the Morgan zone, and above it 13 ft. of glauconitic shale with a few lamellibranchs. Most of the Morgan may have been deposited in off-shore shallows. To July 1941, it had yielded 2,141,040 brl. from fifteen wells.

Time-drilling charts are a valuable adjunct to electrical logs in determining the tops of sands. There is a marked increase in drilling time after the softer Eocene, and Gulf (Upper Cretaceous), and Comanche (Lower Cretaceous) are penetrated. A. L.

103.* Thickness and Structural Study of Major Divisions of Cretaceous System in Nebraska. P. Fuenning. *Bull. Amer. Ass. Petrol. Geol.*, September 1942, **26** (9), 1517.—Isopach maps are presented of the "Dakota", Benton, Niobrara, and Pierre groups, and of the Cretaceous as a whole; also structural maps contoured on top of the Dakota sandstone, Greenhorn limestone, Fort Hayes limestone, and the Niobrara formation.

The thick development of the "Dakota group" in central Nebraska suggests a local basin of deposition, with derivation of sediment from the Sioux Falls "high" and from an elevated area in south-east Nebraska.

Absence of the Niobrara on the north-west extension of the Chadron-Cambridge axis, which runs from north-west to south-east across the north-west quarter of the State, then turning south so as to divide south-west from south-east Nebraska, would point to uplift along this line sooner in the north than in the south. Considerable movement of the axis took place towards the end of, or after, Pierre time. A. L.

104.* Argentina's Goal is Increased Production through Expanded Drilling Activity. Anon., *World Petrol.*, September 1942, **13** (10), 33.—In 1941 Argentina consumed

5,088,000 tons of oil and produced 3,226,000 tons. The total fuel consumption was equivalent to 10,364,000 tons of petroleum. In 1937 3,061,000 tons of coal were imported, about two-thirds of it from England, whence the supply was cut off on the outbreak of war. Imports of oil have also been seriously curtailed. Consequently various measures for limiting fuel consumption have been proposed. The fuel oil shortage is more serious in some respects than the shortage of gasoline. There has been a demand for greater drilling and exploration activity, and a suggestion that some of the State reserves should be released for development by independent companies. A shortage of drilling equipment exists.

During 1941 there was a substantial rise in drilling, 364 wells being completed, 228 by the State. At the end of 1941 Comodoro Rivadavia had 3021 wells, and Mendoza had fifty-one wells in operation, Plaza Huincul 274, and Salta 157. During 1941 1,282,706 ft. were drilled. 22,013,471 brl. of oil were produced, 7% more than in 1940. During the first five months of 1942 the output was 7% above the figures for the corresponding months of 1941.

In 1941 the El Tordillo zone was opened in the Chubut area. Argentina's deepest well (9500 ft.) is in Mendoza province. This well penetrated oil sands which have not been fully tested. The Mendoza production increased by 33% in 1941. Two substantial producers were completed in the Challaco zone of the Plaza Huincul field.

Argentina's refining capacity is over 90,000 brl./day, sufficient to handle the domestic production, together with the normal imports of 10,000,000–12,000,000 brl./year.

Tables give the production by companies and by fields in 1939, 1940, 1941, and part of 1942 (first five months), and the capacities of the refineries and the products.

G. D. H.

105.* Bolivian Production to be Trebled by 1944. Anon. *World Petrol.*, September 1942, **13** (10), 41.—At present Bolivia produces 114,338 brl. of gasoline per year, 61% of the domestic requirements. It also produces 11,815 brl. of kerosene, or 58% of the total consumption. In 1941 10,193 brl. of diesel oil and 97,284 brl. of fuel oil were produced, which were respectively 7% and 31% of the country's requirements. Bolivia's annual crude production is 233,630 brl. Up to 1st April, 1942, 900,000 brl. had come from seven wells at Sanandita, and about 800,000 brl. from two wells at Camiri. Between these two fields three producing wells are shut in at Camatindi, while near the Argentine border is the Bermejo field.

Camiri gives 500 brl./day, and has a proved area of 640 acres, with a potential area favourably located on structure of a further 5000 acres. Oil is obtained from the Devonian at a depth of 3200 ft. At Camatindi 1120 acres are considered to have been proved, with an additional 2000 acres favourably located on structure. Production is from a depth of 4000 ft. Sanandita gives 380 brl./day, and it is expected that the output may rise to 1775 brl./day in the next eighteen months. The oil is believed to come from the Triassic at a depth of 2100 ft. About 300 acres have been proved, and a further 1600 acres are favourably situated on structure. Bermejo has a proved area of about 600 acres with three separate producing zones at 2214 ft., 2870 ft. and 3600 ft. in the Jurassic. This field has been shut in for the past twelve years.

A 2000-brl./day topping plant is planned for the Oruro mining district to supply petroleum products for the expanded mining operations. The oil will be drawn from Sanandita.

G. D. H.

106.* Brazil Continues Exploratory Drilling. Anon. *World Petrol.*, September 1942, **13** (10), 70.—After preliminary geological and geophysical surveys several districts in different parts of Brazil were considered sufficiently promising to warrant testing by drilling. The first area for testing was along the eastern coast of Bahia, and at Lobato, near Salvador, a Cretaceous oil-bearing horizon was penetrated at a depth of 702 ft. in January 1939. This well was not commercially productive, but three wells in 1940 and three more in 1941 were drilled to various depths in the Cretaceous-Tertiary belt in Bahia and Alagoas. Unofficial reports state that production has been established which is considered promising for substantial yields when the structures now being tested have been more fully explored.

Two wells are being drilled near Maceio, Alagoas, and while no commercial production has been obtained, showings of oil have been reported. In the neighbourhood of

Salvador two areas of production have been found in addition to the original Lobato showing. The latter is within the city limits of Salvador, while the new tests are to the north where small producers have been completed on each of the two structures. Shows of oil and gas and said to have been encountered in a well on an island across the bay from Salvador. G. D. H.

107.* Colombian Exploration gives Promise of Important New Production. E. Ospina-Racines, *World Petrol.*, September 1942, **13** (10), 45.—The most promising result of the past twelve months' intensive wildcat exploration drilling is the discovery of the Casabe structure on the west bank of the Magdalena opposite the De Mares concession. Four wells have been completed at Casabe. Wildcatting on the Barco concession has been on a reduced scale. The Petrolea field was completely delimited during the first half of 1941. This field supplies the Covenas pipe-line, which has been operating at only 50% capacity on an average. Recently two new structures have been tested, Socuavo and Tres Bocas, where the first wells have given high-gravity oil.

Cimitarra 1 gave considerable gas, and a second well is to be drilled, while the McCarthy well was abandoned at 5438 ft. The Braval and Culimba tests were abandoned, although a second well is to be drilled at Culimba. The Gutierrez tract, just north of the Casabe tests, has been abandoned. Wildcatting is being carried out in the coastal area (Department of Magdalena) some 125 ml. inland.

During 1941 Colombia had an average oil production of 2,053,000 brl./month, but since March 1942 the average figure has been about half of this. About 45% of Colombia's lubricants are imported, although 90% of Colombia's oil is exported. The Barco refinery supplied 1,320,000 gal. of last year's gasoline consumption of 51,400,000 gal.

50% of the country's prospective oil land is over 750 ml. from tidewater in the Llanos region. Experience has shown a lapse of six to ten years after the discovery of an oilfield in Colombia before its oil is sold in the world market. Some of Colombia's markets are likely to disappear after the war. In spite of the fact that Colombia produces only 1·1% of the world's oil, oil exploitation is of considerable significance in the country's economy, and in 1940 Government income from the oil industry was 14·7% of the total revenue. G. D. H.

108. Michigan Oil Exploration More Important in Wartime. N. X. Lyon. *Oil Wkly*, 26.10.42. **107** (8), 19.—Michigan has never given more than 2% of the annual U.S. production, and its reserves have been only 0·2–0·3% of the U.S. total in the past five years. For some years 20,000–30,000 brl./day were shipped by tanker to various eastern and southern points, but in 1937 an 8-inch pipe from Mt. Pleasant to Toledo was completed, and water transport to the south was largely discontinued. While the State exports 15,000–20,000 brl./day, it imports 25,000–30,000 brl./day. The Toledo call on Michigan crude has been strengthening monthly as the Illinois oil production has fallen or been diverted to the east. The eighteen independent refineries in Michigan had a raw charge capacity of 56,900 brl./day on 1st August. Their cracked gasoline capacity is about 8000 brl./day, excluding a refinery at Trenton, which is supplied with crude from Oklahoma and Illinois, and which has facilities for 10,000 brl./day of charging stock for cracked gasoline.

The producing areas lie in two general provinces, the Basin and the Southwest area. The Basin has more fields and the higher recovery per acre; the structures are also larger. Geophysical work has not proved of material value in either province, and so deep drilling and coring provide the principal geological data. In Southwest Michigan the Traverse lime is the main producing horizon, being 1000–2000 ft. deep, and characterized by coral reefs and extremely erratic trends and structures. Most of the discoveries there in the last three years have been the results of wildcats drilled on "hunches".

The discovery of Reed City and Headquarters in 1941 caused attention to be concentrated on the Basin. This year the outstanding development has come from deep drilling to the Richfield-Sylvania series rather than from the uncovering of new pools in the Dundee and Traverse. The Richfield–Sylvania development zone is about 1300 ft. below the top of the Dundee lime. Several fields have been opened, but neither the fields nor the wells are large, for the horizon, an intermediate section of the Monroe, has not sufficient porosity to give large wells. The Richfield horizon has good pros-

pects, since it covers the entire basin. The Richfield-Sylvania is 3600–5100 ft. deep, and is underlain by salt, with the next potential oil horizons, the Niagara and Trenton, at depths of 8000–10,000 ft.

In Southwest Michigan small gas wells have been completed in the Monroe at Grand Rapids. Wells drilled to the St. Peter sand found no important oil-shows below the Traverse.

Considerable areas have yet to be explored fully. Drilling costs will be less in the Southwest than in the Basin, because of the shallower wells needed in the former area. The best fields have had reserves of 15 million to 25 million brl. of oil. At present Michigan is producing about 43,000 brl./day from prorated fields and 22,500 brl./day from settled fields. The allowables are comparatively high, 20-acre unit wells have had a flat rate of 150 brl./day this year, and 40-acre unit wells have had 262½ brl./day. Regular surveys are made to check gas/oil ratios, bottom-hole and reservoir pressure changes and water conditions.

Tables give data about the leading oilfields of Michigan, and the results of wildcat and other wells during the past five years. G. D. H.

109. Peruvian Oil More Important with War. Anon. *Oil Wkly.*, 26.10.42, **107**, (8), 40.—Oil production in Peru rose from 10 million brl. in 1931 to a peak of 17,595,000 brl. in 1937, but it fell to about 13 million brl. in 1941, partly due to the loss of European markets. The present refining capacity of the country is 21,720 brl./day, and it could easily to expanded.

There are indications of additional oil reserves on the eastern slopes of the Andes, in areas connected by river transport with the Upper Amazon Basin. G. D. H.

110. Taber Well Makes Largest Flow in Canada. Anon. *Oil Wkly.*, 26.10.42, **107** (8), 40.—The well at Taber, southeast of Lethbridge, is producing oil at the rate of 330 brl./day, being the largest producer outside Turner Valley. It may indicate the existence of a new major oilfield.

Fifty wells are to be drilled at Vermillion. G. D. H.

111.* Declining Rate of Discovery Poses Urgent Problem for Oil Industry. A. I. Levorsen. *World Petrol.*, November 1942, **13** (12), 37.—The developed or known production is that from which present production is being drawn. Of this reserve only a certain amount is recoverable, the amount depending on a number of factors. The amount of recoverable reserve in U.S.A. has increased year by year, being about 5000 million brl. in 1920, 10,000 million brl. in 1930, 18,000 million brl. in 1940, and 19,800 million brl. on 1st January 1942. These figures are estimates of the oil recoverable by methods and under the economic conditions of price and markets then prevailing. Production has risen from 442,929,000 brl. in 1920, 898,011,000 brl. in 1930 to 1,338,237,138 brl. in 1940, and consumption has kept pace. In general, during recent years the reserve has been twelve to fifteen times the annual production, although only a portion of the reserve, perhaps a quarter or a fifth, is producible in the next few years, while the rest will be obtained at steadily declining rates over a period of twenty to thirty years or more. Thus unless new fields are found the existing supplies would not meet daily demands for long.

Production at an excessive rate reduces the ultimate recovery. Studies are being made to find the amount of excess producing capacity in the U.S.A.

Since 1860 about 45,000 million brl. of oil have been discovered, and of this 25,000 million brl. have been produced. If the same rates of expansion continue in 1952, 22,000 million brl. more will have been found, and of this 17,000 million brl. will have been produced; in 1962 the cumulative discoveries will have totalled 90,000 million brl., with 60,000 million to 65,000 million brl. of it produced. Hence to maintain the same rate of increase in supply and demand in the next twenty years, with the same ratio of reserve to annual consumption requires the discovery of a quantity of oil equal to that found in the past eighty years.

Present geological knowledge indicates with considerable assurance that much oil remains to be discovered. The undiscovered reserves are of two types: (*a*) Within areas of current development and production in extensions, deeper production, and new fields. This represents the bulk of current finds and the most readily available

reserve for the immediate future. (*b*) Reserves in partly explored regions fringing the areas of current development—*e.g.*, the Trans-Mississippi region of Southeast U.S.A.; Trans-Pecos region of West Texas and New Mexico; Anadarko Basin; basins within the Rocky Mountain area; Plains region of North and South Dakota, Nebraska, Montana, and Wyoming (parts); northern two-thirds of San Joaquin Valley.

In the Dakota region there are over 10,000 ft. of sediments, and this is the southern end of a large province which has oil at a number of points. In the Dakotas so far only traces of oil and gas, with considerable thicknesses of porous beds, have been found in the five or six deep tests. Success would open up a large area for active exploration extending north to the Arctic.

Structural traps have been sought by many methods, but the declining discovery rate shows the decreasing effectiveness of the existing methods. Stratigraphic traps have generally been found by random drilling, and ways of locating them more readily are being sought, for some of these fields are among the country's largest.

Several writers have called for more vigorous wildcatting, the testing of new methods of locating wells, and the employment of more geologists and geophysicists. It certainly appears that means must be sought to stimulate wildcat drilling. G. D. H.

112. **Advance in Oil Prices Needed to Avert Threatened Shortage.** M. G. Cheney. *Oil Wkly*, 2.11.42, **107** (9), 15–17.—Besides being required in the form of ordinary and special products for war and industrial purposes, petroleum is now a raw material for the manufacture of rubber, explosives, etc. Various changes have been forced on the oil industry without adequate compensating adjustments in the price ceilings, now 40% below the 1926 figures. Early in the war it was thought that the United Nations' essential needs could be met out of known excess reserves, but that does not seem to be quite so certain now. The loss of the East Indian and Burmah production was unexpected, and the U.S.A. rate of drilling has declined 50%, while the number of producing wells completed has fallen 61% due to various factors. A further curtailment of drilling is expected.

In Texas nearly 2200 small oil wells were plugged during the first nine months of 1942, 50% more than in the whole of 1940. At least 100,000 more small oil wells are in jeopardy. Stripper production is said to be 16% of current production and 20% of present reserves. The existing adverse economic conditions must be held responsible for this physical waste by premature abandonment and the consequent necessity to produce other wells at excessive rates.

A reappraisal both of known recoverable reserves and possible additions by extensions to present fields has nearly been completed, together with a determination of the maximum efficient rates of production for the various fields. The Texas known recoverable reserves are 11,000–12,000 million barrels, 50% of the U.S.A. total, and the current output is 5000 million barrels per year, or 34% of the U.S.A. total. It is probable that few Texas fields are under-produced. Three-quarters of the reserves may be in reservoirs mainly of water-drive where production at rates greater than the rate of water movement is wasteful. Efficient rates of production in the gas-drive fields are determined partly by gas/oil ratios, and partly by considerations involved in returning gas to the reservoir.

In the period 1926–31 geological and geophysical work, and random drilling respectively discovered 5800, 800, and 4500 million barrels of oil, East Texas contributing the bulk of the reserves attributed to discoveries by random drilling. During the period 1934–38 the corresponding figures were 2000, 300, and 60 million barrels. The reflection seismograph was the most effective geophysical instrument in making discoveries in this second period.

Numerically, discoveries have been maintained since 1939, but they seem far less prolific than before. In 1941 one out of four wildcats located geophysically was successful, one out of five for wells located by geology and geophysics, one out of 5·6 for geology alone and one out of 26·7 for wells located non-technically.

Current oil prices should take into account the probable future costs of finding at least 1500 million barrels of new reserves annually. Pratt estimates that discovery costs have increased over 300% during the last few years.

It seems that the consumer would be much better off paying somewhat higher prices now rather than risk facing excessive price advances later under a condition of great scarcity. G. D. H.

113.* Location of Oil Reserves Big Factor in Supply Deficiency. W. V. Howard. *Oil Gas J.*, 19.11.42, **41** (28), 14.—A study of the geographical relationships of the U.S.A. oilfields and refineries shows that there is a shortage of 300,000 brl./day in the area east of the Sierras, if refinery runs are to be maintained at last year's level. The situation east of the Indiana–Ohio line remains practically unchanged. A rise in Kansas has been more than offset by a drop in Oklahoma and Nebraska, so that the amount of oil which must be transported across the Oklahoma and Kansas State boundaries is 167,000 brl./day more than it was a year ago. The Arkansas–Louisiana–Mississippi area has maintained its production, and the Rocky Mountain region shows an increase. Texas and New Mexico now produce 99,000 brl./day less than a year ago.

The decline in production may be merely a matter of transportation difficulties, but there is the possibility that production cannot be stepped up in any part of the country to meet the estimated demand. It is possible that 1943 will see as much or more construction of new pipe-lines or the relaying of old ones as has taken place in 1942.

Reserves of 20,000 million brl. might be expected to furnish more than 4 million brl./day. Assuming the existence of transportation facilities adequate to handle this production in all areas, output could probably be stepped up, but the increase in production would cause a decline in reserves equal to much more than the amount withdrawn.

The more effective the proration in a field the more nearly its years' supply approaches its productive life, although even in these areas a time comes when actual production falls below current allowables, with a resulting extension of the physical life of the field. Generally it may be considered that if a State is withdrawing oil at the rate of more than a thirteenth per year of its proven reserves, it is over-producing, and as a consequence the production may be expected to decline in the near future, unless it is augmented by discoveries of major importance. It appears that relatively few areas east of California are annually producing less than a thirteenth of their proven reserves, and these include Colorado, New Mexico and Texas, except the South and South-Central districts.

Tables show the relationship between refinery runs and production in the various major districts, and the increase in years' supply with declining production.

G. D. H.

114.* Typical Oilfield Structures: Regional High; Panhandle and Hugoton Fields, Texas, Oklahoma, and Kansas. Anon. *Oil Gas J.*, 19.11.42, **41** (28), 38.—The Panhandle–Hugoton area is the largest gas-producing area yet found. At the surface are Quaternary and Tertiary continental deposits, underlain by Permian red beds with anhydrite and gypsum, salt and anhydrite, and limestone and dolomite, which rest on the buried extension (Amarillo) of the Wichita–Arbuckle mountain system. With the subsidence of the Amarillo mountains, faulting took place, and continued for a considerable period. The oil and gas accumulations in the Panhandle sector are largely confined to the ridge and to the area to the north, although the famous Amarillo gas-field, which has much helium, is on the Bush dome to the south. Apparently the Hugoton-area is on a monocline with the Permian beds dipping east. The lowest production is from the granite wash. Above are four limestone or dolomite zones, the lowest being considered to be of Cisco age, and the rest Permian.

Oil is found along the northern margin of the Panhandle area, with gas over the top of the high and throughout the Hugoton district. The uniformity of the initial pressures throughout the area, as well as in the different pay horizons, suggests that the reservoirs were connected, although secondary cementation may later have separated large sections from one another.

Granite highs may be located geophysically, or by surface and subsurface geology combined. Structural conditions leading to the discovery of such fields as Hugoton are difficult to locate, and speculative thinking coupled with random drilling seems to be most successful at present. Detailed subsurface and geophysical work may reveal favourable structural conditions for the localization of oil and gas on the flanks and crests of buried granitic highs.

G. D. H.

Drilling.

115.* Drilling-Time Logs and their Uses. R. Willis and R. S. Ballantyne. *Bull. Amer. Ass. Petrol. Geol.*, July 1942, **26** (7), 1279–1283.—Drilling-time can easily be noted for

each foot of beds penetrated, and the time in minutes can be plotted to give a graph suitable for purposes of correlation. Such graphs are a valuable check if used in conjunction with electrical logs. They are also handy in plotting boundaries when, in contrasting sandstone and shale beds, parts of the core are lost. They also help in measurements for gun-perforating. A. L.

116.* Inexpensive Features Refine Cable-tool Rig. G. M. Wilson. *Oil Wkly*, 28.9.42. **107** (4), 15–19.—The field in which these unitized rigs are used is in West Texas, and cable tools are particularly suited for the conditions encountered. The cable-tool rigs are all electrically powered. One of them uses a conventional derrick, while another is equipped with an A-frame mast, but they are similar in that each employs a unitized, skid-mounted motor-house, and the power is supplied to the spudding unit through a conventional belt and band-wheel arrangement.

A definite advantage is gained—on cable-tool rigs in particular—by the use of two motors instead of a single large one. As drilling progresses and the hole becomes deeper, the rhythm or frequency of the walking-beam strokes must be continually adjusted to an optimum speed; a speed at which the greatest rate of penetration for a given number of strokes/min. is attained. The desired speed will often lie midway between two points on the controller if but a single motor is used. With the dual power-source, however, the controller of one motor may be set on the closest point and the other controller set on the next higher or lower point, depending on which direction is desired. This splitting of points tends to average the speed, thus enabling the driller to have more complete control of the spudding frequency.

An interesting item is a novel shock-absorber used in spudding. Instead of employing the usual temporary method of utilizing a spudding pole, this company obtains the spudding action directly from a take-off on the crank. A large sheave having a wide groove is placed on the crank-pin, and the drilling line is taken off the reel, run under the sheave, then over the crown block, then down to the hole. The shock-absorber device is placed under the line midway between the reel and this sheave.

The shock absorber is shop-made, and consists of a long piston working inside a cylinder, the latter being a 3-ft. length of 6-inch pipe. At the bottom of the cylinder is a heavy coil spring of the type commonly used on the front-wheel assemblies of automobiles, and on which the piston rests in a vertical position. A small half-moon-shaped sheave over which the cable runs is mounted on the top of this piston. The assembly stands approximately 4½ ft. high, and in the operating position beneath the line, exerts a strong upward tension against the drilling line at this point during the complete revolution of the sheave turning on the crank pin. The piston is close-fitting in the cylinder, and is kept lubricated with a heavy oil for smooth acting motion. Well braced, and mounted on a broad base, the shock-absorber is lag-screwed to the derrick floor to prevent its "walking" while in operation.

The spudding sheave, in making each revolution, alternately pulls down and releases the drilling line, producing the desired spudding action of the bit. In addition to the tendency to smooth out the drilling stroke, the shock-absorber holds the cable in forceful contact with the spudding sheave to eliminate lost motion and helps to eliminate much friction and wear on the line at that point.

A number of other details are similarly described. A. H. N.

117.* Unique Boiler Setting Carries Own Foundations. J. C. Albright. *Oil Wkly*, 5.10.42, **107** (5), 24.—An installation of drilling boilers now in use in California has been designed so that the amount of labour and time required for either setting-up or dismantling has been materially reduced, and so only the minimum amount of equipment necessary for efficient operation and convenience of the operator is used. In addition to carrying its own foundations, thereby saving foundation time and reducing the non-salvagable material remaining when moved to a new location, all fittings and connections of the battery are equipped with unions so that dismantling and erections can be accomplished quickly, with little effort, and without requiring heavy wrenches. Naturally the expense of boiler installation has been reduced by these features.

Five conventional oilfield boilers make up the battery, one of which is used as a spare. Gas is employed for fuel. The burners are grouped in a compartment attached below the boiler firebox by means of staybolts which pass through lugs welded to the outside of the side sheets and through holes made in short joint of pipe attached to

the bottom at each end of the burner attachment. These four bolts, one at each corner, have proved sufficient to retain the burner assembly in place, which means that only four nuts need be removed for disconnecting either to service or move the burner compartment to another location. The supports for the smokebox and the rear ends are described and illustrated photographically.

Pumps are set on unitized bases with all necessary piping permanently connected, so that the water supply, steam for power, and the exhaust and discharge lines can be made up by using each section in its individual place. The heat for the boiler-feed water is the exhaust from the feed-pumps, plus any required from the rig engines which can be conveniently piped to the boilers. The expense of this type boiler equipment is obviously less than many other types, and the quantity of material remaining at the setting after the boilers have been moved is almost negligible.

A. H. N.

118.* New Problems Faced in Killing Off-Shore Cratered Blowout. N. Williams. *Oil Gas J.*, 5.11.42, **41** (26), 29–32.—Directional drilling is used now in various normal routine matters, but it is in the killing of a cratered blowout well that the proficiency of directional control of drilling is demonstrated most impressively. Here, a relief well is drilled from a convenient, safe surface location to a precalculated position in close proximity to the bottom of the blowout well, and by pumping fluid and mud through it into the producing formation around the bottom of the well the flow and pressure are readily choked. The paper deals with one of the latest and most difficult of these jobs. At a depth of 8570 ft., the well was one of the deepest to which there had ever been occasion to drill a directional relief well. Bottom-hole pressure was estimated to be around 5780 lb., which was equivalent to " normal " Gulf Coast pressure at a depth of 12,280 ft. This added not only to the hazards of drilling the relief well, but also to the problems of killing the flow in the blowout well, requiring the provision of an elaborate assemblage of pumping and steam-generating capacity. After putting 210 tons of junk on the well to localize the dangers, the well cratered and these disappeared into the bay. A relief well was then drilled.

In calculating the objective of the relief well it was known from slope tests that the bottom of the crated well was within a radius of 126 ft. of its projected vertical hole. The direction of the deviation from vertical was not known, but in drilling the well every effort had been made to maintain the hole as nearly straight as possible, and frequent check had been made of the amount of the deviation. Consequently, if the bottom of the relief well was placed within this radius of the projected vertical it could not be more than 252 ft. from the actual bottom of the crater well. The latter would be the case only if the bottoms of the two wells were on a periphery of the circle described by the 126-ft. radius at points opposite each other on a line through the centre. The chances were that the bottoms would be much closer.

Final calculations on completion of the relief well indicated its bottom was approximately 44 ft. from the projected vertical of the crater well. At this point the actual distance it could be from the actual bottom of the crater well was 170 ft. (126 ft. plus 44 ft.), but it could have been bottomed immediately adjacent to the blowout well. Measured total depth of the relief well was 8683 ft., at a point 944·65 ft. north 45° 05′ west from the surface location. At that point the vertical depth was 8586·90 ft. as compared with the depth of 8570 ft. of the crater well. Details and troubles encountered in drilling the relief well are given.

A. H. N.

119. Patents on Drilling. E. E. Miller. U.S.P. 2,295,678, 15.9.42. Appl. 17.3.41. Mud-pump piston consisting of a specially constructed core and rubber on the outside.

C. M. O'Leary. U.S.P. 2,295,803, 15.9.42. Appl. 29.7.40. Cement shoe having flexable hellically inclined external surface vanes.

A. L. Armentrout. U.S.P. 2,295,822, 15.9.42. Appl. 14.9.40. Apparatus for cementing objects in well-bores.

W. B. Campbell and J. M. Johnson. U.S.P. 2,295,932, 15.9.42. Appl. 6.3.41. Cathead with spirally grooved drum.

J. D. Hall. U.S.P. 2,296,161, 15.9.42. Appl. 2.11.40. Lateral drill for wells using flexible drill-pipe to go into the walls of a well.

J. Neufeld. U.S.P., 2,296,176, 15.9.42. Appl. 9.3.40. Well-survey method and apparatus using radioactive radiations.

Z. B. Richard. U.S.P. 2,296,183, 15.9.42. Appl. 27.11.40. Drill-bit of the fish-tail type with parallel sides.

H. J. von Rosenberg. U.S.P. 2,296,186, 15.9.42. Appl. 5.5.41. Portable derrick fitted with wheels.

A. Boynton. U.S.P. 2,296,198, 15.9.42. Appl. 22.9.38. Threadless drill-pipe.

G. H. Ennis. U.S.P. 2,297,754, 6.10.42. Appl. 28.12.36. Method of locating strata in wells and electrode apparatus therefor.

J. G. Campbell. U.S.P. 2,297,939, 6.10.42. Appl. 9.10.40. Method of detecting the penetration of an oil-bearing horizon by testing for oil in the drilling fluid as it enters and leaves the well.

R. I. Gardner. U.S.P. 2,298,049, 6.10.42. Appl. 26.11.40. Tool-joint for rotary well-drilling.

C. R. Irons. U.S.P. 2,298,129, 6.10.42. Appl. 29.3.38. Treatment of wells to seal and consolidate a stratum penetrated by the bore-tool.

E. H. Lamberger and B. F. Langer. U.S.P. 2,298,216, 6.10.42. Appl. 26.9.39. Weight indicator for rotary well-drilling.

P. McShane. U.S.P. 2,298,222, 6.10.42. Appl. 7.3.40. Automatic feed for rotary well-drills by electrically weighing the drill-string, and thus controlling the motor.

G. L. Kothney. U.S.P. 2,298,706, 13.10.42. Appl. 18.11.40. Method and apparatus for orienting tools in wells.

L. G. Howell. U.S.P. 2,298,794, 13.10.42. Appl. 23.6.41. Well-logging using Geiger-Muller counters.

T. K. Stinson and L. K. Ayers. U.S.P. 2,298,984, 13.10.42. Appl. 28.5.37. Iron oxide weighting material for drilling muds.

P. T. Bynum. U.S.P. 2,299,076, 20.10.42. Appl. 30.1.41. Side-wall sampler for drilling wells.

J. A. Muller. U.S.P. 2,299,171, 20.10.42. Appl. 18.1.41. Rotary hose coupling for high pressures.

J. A. Muller. U.S.P. 2,299,172, 20.10.42. Appl. 10.12.41. Rotary hose coupling assembly for high pressures.

R. H. Crow. U.S.P. 2,299,383, 20.10.42. Appl. 20.11.39. Portable derrick.

R. E. Conner. U.S.P. 2,299,528, 20.10.42. Appl. 22.9.41. Casing-mill for cutting pipes in wells.

A. R. Maier. U.S.P. 2,299,528, 20.10.42. Appl. 15.6.36. Oil-well drilling apparatus using steam-engines.

A. R. Maier. U.S.P. 2,299,549, 20.10.42. Appl. 12.9.40. Well-drilling rotary machine with a lubricant pump.

J. E. Hall. U.S.P. 2,299,978, 27.10.42. Appl. 25.6.38. Casing protector for drill-pipes and the like.

G. L. Scott and W. B. Noble. U.S.P. 2,300,016, 27.10.42. Appl. 3.4.39. Directional drilling apparatus comprising a device carried in a drilling-bit.,

B. F. Kelly. U.S.P. 2,300,122, 27.10.42. Appl. 23.3.39. Cathead and spinning drum assembly on one shaft of a draw-works.

E. L. Johnston. U.S.P. 2,300,384, 27.10.42. Appl. 29.1.40. Method of locating stuck pipe in wells. A. H. N.

Production.

120.* Graphical Mechanics of Counterbalancing Individual Well-Pumping Units. J. J. Laudermilk. *Oil Wkly*, 28.9.42, **107** (4), 20–24.—The principles of finding graphically the resultant torque curve for a pumping installation fitted with counter-

balance are given in detail and illustrated by working out completely a typical example. The first step for the counterbalancing of an individual well-pumping unit by use of graphical mechanics is to secure a drawing of the individual well-pumping unit in question. This can be done very simply if the unit is in operation. By merely measuring the existing physical dimensions of the unit the engineer will be able to draw his preliminary sketch. This process will be much simpler if an existing drawing of the unit has been furnished by the manufacturer. The second step in the preparatory field-work necessary is to undertake dynamometer well-load studies and obtain the normal card under desired conditions of operation. It is also necessary to determine the type and physical characteristics of the counterbalance in use on the well.

After these two steps a line drawing is made of the mechanism. This includes (1) crank-pin, (2) crank, (3) wrist-pin, (4) circle of travel of wrist-pin, (5) circle of travel of centre of gravity of counterbalance, (6) pitman, (7) stirrup bearing, (8) arc of travel of stirrup bearing, (9) saddle-bearing, (10) sampson post, (11) arc of travel of horsehead, (12) and an arbitrary distance measured from the point of contact of the arc of travel of the horsehead and the straight-line motion of the polished rod to an arbitrarily established point on the line of action of the polished rod. The drawing must be accurate as any error introduced here is cumulative in subsequent operations. From this diagram and a dynamometer card resultant torques are calculated. A. H. N.

121.* Ten Years of Conservation Keep Conroe Wells Flowing. W. L. Baker. *Oil Wkly*, 5.10.42. **107** (5), 17.—The Conroe oilfield has produced one-fifth of its estimated ultimate recovery since it was discovered 10 years ago, yet, due to early adoption of modern conservation practices on a widespread scale, the field's reservoir pressure has been husbanded to the point that some 93% of the wells are still flowing naturally, and only nine producing wells have been abandoned. The reservoir pressure of the principal producing formation, which has produced 120 million barrels, or 90% of the field's total to date, is but 222 lb. lower than the original, a change of only 1·85 lb./million brls. of oil produced. Significantly most of this energy loss occurred in the first eighteen months, or before conservation was adopted to a material extent. A decrease of only 90 lb. while producing 113 million barrels, or 0·79 lb./million brls., has been recorded in the past nine years; and currently its pressure is identical with that existing four years and seven months ago, although over 42 million barrels of oil have been recovered from the horizon during the interval.

The field was drilled following a wide spacing pattern. This amounted to large reduction in drilling cost and conservation of reservoir energy simultaneously. The conservation of energy was further enhanced by careful completion and choking of wells and proper withdrawal rates to utilize most effectively the water-drive present. Details of these practices are presented.

The practice of gathering produced salt-water in lease-pits where it either evaporates or is turned into natural drainage channels during rainy seasons is the common disposal system at Conroe. During the past two years a number of new earthen storage pits were built or old ones enlarged due to the increase in water production. There also has been some recent activity towards use of disposal wells for the subsurface injection of salt-water. The disposal of salt-water by this means is still in its initial stages, but appears successful, and additional installations are likely. A. H. N.

122.* Ingenious System for Starting Central Power Engines. E. Sterrett. *Oil Wkly*, 5.10.42, **107** (5), 30.—An ingenious method of kicking off the two-cylinder two-cycle 100- and 150-horse-power engines used by one company for actuating its powers was developed to replace the former method of "cranking" the unit by revolving it under manual power—applied by climbing the spokes of the flywheel until a charge of fuel has been drawn into the engine, then carefully compressed to a setting in the operating cycle as close to the firing point as can be judged, after which the ignition is snapped on or the magneto breaker flipped to fire the compressed charge. Due to the limited arc of flywheel rotation in which ignition occurs with normal timing, this operation generally is unsatisfactory as well as hazardous, and requires close co-ordination between the man rocking the engine and the one manipulating the spark.

The plan as adopted involves the use of a compressor unit, but instead of a storage tank large enough to furnish several fillings of the engine cylinder, a small or garage-type compressor is used, belt-driven by a ½-horse-power gasoline engine. This entire

unit costs less than the storage tank sometimes provided for high-pressure air starting, occupies but a small corner of the engine-house, and can be started readily and operated by one man.

Aside from the expected elimination of accidents caused when attempting the starting of the power units, the availability of the pre-mixed charge, and consequent easy starting, helps prevent accidents formerly caused by the pumper, attempting minor adjustments to the engine while operating. This easy re-starting after shut-down means that the worker no longer chances injury—and possible dismissal—by failing to observe the company's order to shut down the engine before working on it.

A. H. N.

123.* Metering of Oil-well Production. *Part* 1. G. L. Paulus. *Oil Wkly*, 12.10.42. **107** (6), 17.—Advantages of metering over using gauge-tanks to measure well production are briefly discussed, savings in steel required and amount of oil stored above ground at any one time being indicated. Metering in the field is then reviewed historically from 1924, when the first oilfield meter was installed. The problems connected with metering oil weeks are great, since it is possible for the meter to receive into its measuring chamber a mixture composed of the following: (1) mixture of hydrocarbons which are in the gaseous state at the temperature and pressure of metering; (2) mixture of hydrocarbons which are liquid at the temperature and pressure of metering; (3) salt-water and its accompanying water vapour; (4) hydrocarbon wax which has a consistency of cup grease at metering temperatures and pressures; (5) formation sand; (6) precipitated salt scale; (7) foreign solid materials such as stuffing-box rubber-packer rubber and canvas, waste, and rags, the last of these two being introduced by careless workmen; (8) chemicals which are corrosive, such as sulphur compounds, and (9) chemicals for dehydration purposes which are often introduced upsteam of the meter.

The production from an oil-well may consist of as few as two of the above materials, but it is not uncommon to find all present. Unfortunately, most of the meters available for production measurement have been designed to handle relatively clean liquids, and in most cases the meter which has been designed for clean liquids is tried on oil-well production without any changes, with the hope that it will happen to have been designed in such a manner as to do the job satisfactorily. Three types of meters are studied in the paper: (1) positive displacement, (2) current, and (3) weighing meters, Part 1 being devoted entirely to the first type. Accuracy, maintenance, and effects on tolerances, etc., are discussed in detail.

Most positive-displacement meters do not account for the change in volume of the oil due to a change in temperature, and record only a definite volume/cycle. However, some meters now on the market are provided with a thermostat which causes the meter to register a 60° barrel at all times. These thermostats come with the meters as extra equipment, and are expensive in relation to the cost of the meter. They correct on the basis of the expansion factor of the liquid metered. Thus, unless the meter is measuring a relatively dry oil the correction would be in error, because of the mixture of oil and water involved. To hold the thermostatic correction accurate, the coefficient of expansion for the mixture would have to be used and an adjustment made whenever a change in composition occurred. The difference in volume between 60° oil and oil at the temperature of metering generally is only about 1 or 2%, so it is believed that until such time as this type of meter can be held to closer accuracy while metering oil-well production, the thermostat is not essential. In most cases accuracies better than 1 or 2%, although desirable, are not absolutely necessary when handling well production. In places where greater accuracy is necessary, the expense of metering the well production rises rapidly. With the meters now available, this expense would be almost prohibitive if the meters were held to a registration as close as plus or minus 1/2%.

A. H. N.

124.* Conservation of Gas in Louisiana. H. W. Bell. *Oil Wkly*, 12.10.42, **107** (6), 28.—The legal and engineering aspects of natural gas production and conservation are discussed in some detail.

A. H. N.

125.* Casing Corrosion in Oilfields Producing Sour Gas. T. D. Bailey and A. M. Crowell, *Oil Gas J.*, 15.10.42, **41** (23), 31.—Operators in the sixteen sour gas-producing

oilfields of southern Arkansas have been requested by the State of Arkansas to take preventive measures to guard against corrosive action of hydrogen-sulphide-bearing gases found in these reservoirs. While damaged casing has been found only in the Magnolia field to a large extent and the Atlanta and McKamie fields to a minor extent, the imminence of corrosive action in the other fields has caused the State Commission to include them in their workover requests. A table gives relevant data about the fields and the fluids found in each. Two theories are advanced for the severe corrosion: (1) electrolysis and (2) electrochemical or galvanic action resulting from the presence of hydrogen sulphide. The latter theory seems to have the most support.

Working on the electrolysis theory, several tests were made to determine if a current of electricity was actually flowing through the gathering lines. Results of these tests showed that currents of 0·3–3 amp. were found to be present in the flow-lines. This current was found to flow towards the well in all cases. Although this current is small, considerable electrolysis could take place over a long period of time. Theoretically, a current of this size could remove 15–20 lb. of metal/year. At any rate, this theory should not be entirely overlooked. Electrochemical or galvanic action resulting from the presence of hydrogen sulphide in the gas seems to be the most prevalent theory because of the high concentration of hydrogen sulphide present in the Magnolia field. This theory is discussed on the basis of Prof. Cloud's studies in his book "Petroleum Production."

Since there are good arguments for both the theories given, precautions are being taken against both possibilities. The electrolysis possibility is being easily remedied by placing insulated connections on the flow-line at the point of connection to the well or separator. Possibility of electrochemical or galvanic action due to the presence of hydrogen sulphide is being guarded against by setting corrosion-resistant packers above the producing formation between the tubing and oil-string and by filling the annular space between these two strings with either oil-base mud or sweet oil. The annular space between the water string and surface string is also being kept filled with mud or oil. As an added measure of safety, a commercial inhibiter might be added to the mud or oil behind the packer to reduce corrosion further. A. H. N.

126.* Effects of Well-Cleanout Work in Venango District. R. B. Bossler and P. A. Dickey. *Oil Gas J.*, 29.10.42, **41** (25), 33.—It costs nearly as much to operate a well producing a small amount of oil as it does to operate a well producing a large amount. This simple fact accounts largely for the vastly different costs of production in different parts of the country and even in different parts of the same pool. Costs of production differ widely in the Kane–Butler district of Pennsylvania, even between adjacent leases, depending on how intensely they are being repressured and their general condition and efficiency, as well as on the richness of the sand.

In September 1941 various producers submitted costs of production to a committee of the Pennsylvania Grade Crude Oil Association. These data are published in a brief submitted to the Office of Price Administration on September 26. Costs of production in the Kane–Butler area ranged from \$1.34 to \$4.62/brl. (not including interest on invested capital). The lowest cost leases are those undergoing intensive repressuring, while the highest cost leases are those in relatively poor districts where no repressuring is attempted. It should be emphasised that costs for the repressured leases are lower than the non-repressured leases even when depletion, depreciation, amortization, and overhead charges are increased by the secondary-recovery development. The weighted average cost/brl. for the non-repressure properties was \$2.91 and for the repressured properties it was \$2.36. Cleaning-out of wells in order to increase production and thereby reduce costs is discussed.

In the ordinary procedure of cleaning-out a well, the rods and tubing are removed, and the cavings and junk are fished out or drilled up with the tools. It is not considered good practice to drill out all the material at once, and "put the well on the bottom". It is considered better to "keep the tools on top" of the cavings, running a fairly slow motion and short stroke to promote a scouring action on the face of the sand by the bit and rock fragments in the hole. It is also thought that this method will induce the sand to cave, and the cavings will be drilled up as they come in and not be so likely to fall on the tools when they are below the sand. After the material has been removed and the well is clean to bottom, further caving is induced by dumping in several barrels of water and churning it around with the tools.

At this point some operators shoot the well, while others do not. If the well is shot, the charge is usually light; 1 or 2 quarts to the foot. Some operators shoot the wells themselves, using dynamite lowered or often dropped in from the surface. Less water is used for tamping than in a new well, in order to avoid plugging the pores of the sand by water under a large head. After the shot, the cleaning-out operation is repeated, and the tools are run in very much the same manner as before. A. H. N.

127. Patents on Production. L. D. Mowrey. U.S.P. 2,295,598, 15.9.42. Appl. 21.2.40. Well-flowing device with double chambers and a flow-control device.

G. W. Bowen. U.S.P. 2,295,630, 15.9.42. Appl. 18.10.40. Overshot grapple for sucker-rods.

A. J. Collins. U.S.P. 2,295,634, 15.9.42. Appl. 9.2.40. Gun for perforating well-casing within the well.

S. J. Dietzmann and K. F. Riemann. U.S.P. 2,295,720, 15.9.42. Appl. 16.4.41. Sucker-rod tool with a frame to be clamped to the tubing and a rotating gear to be fixed to the sucker-rod.

J. R. Gillbergh. U.S.P. 2,295,738, 15.9.42. Appl. 16.12.40. Method and means for determining the points of ingress of well-fluids.

A. L. Stone. U.S.P. 2,295,873, 15.9.42. Appl. 25.9.39. Well pipe collar.

F. Stone and A. L. Stone. U.S.P. 2,295,874, 5.9.42. Appl. 25.9.39. Adapter for well-pipes having external annular upset.

D. E. Humphrey. U.S.P. 2,296,164, 15.9.42. Appl. 4.10.40. Pump-rod actuator for deep well-pumping.

L. D. Mowrey. U.S.P. 2,296,220, 15.9.42. Appl. 10.6.39. Gas-lift flow device with flow-controlling means.

H. Allen. U.S.P. 2,297,678, 6.10.42. Appl. 2.7.37. Pressure-gauge for very high-pressure readings.

H. Allen. U.S.P. 2,297,679, 6.10.42. Appl. 7.6.38. Pressure-gauge.

E. J. Hudson. U.S.P. 2,297,832, 6.10.42. Appl. 5.11.40. Extraction and treatment of volatile liquid hydrocarbons to maintain the rock pressure in a subterranean reservoir.

J. E. Hall. U.S.P. 2,297,956, 6.10.42. Appl. 28.11.38. Single duct, hydro-pneumatic, well-tool actuator.

J. Kelly, E. W. Ostrom and G. H. Williams. U.S.P. 2,298,567, 13.10.42. Appl. 20.7.40. Pump anchor for wells.

T. V. Moore. U.S.P. 2,298,834, 13.10.42. Appl. 24.5.40. Means for producing oil-wells passing through a plurality of formations.

C. A. Still and A. C. Still. U.S.P. 2,298,985, 13.10.42. Appl. 5.9.40. Paraffin cleaner for oil-wells.

H. M. McClain. U.S.P. 2,299,057, 13.10.42. Appl. 19.9.40. Apparatus for gravel-packing wells.

W. L. Church. U.S.P. 2,299,304, 20.10.42. Appl. 18.10.40. Fluid lift-pump for wells.

C. L. Evans. U.S.P. 2,299,315, 20.10.42. Appl. 5.3.40. Pump.

W. E. Lawson and C. A. Woodbury. U.S.P. 2,299,907, 27.10.42. Appl. 18.8.39. Explosive charge for oil wells, the charge being in fluid form.

E. E. Clayton. U.S.P. 2,300,103, 27.10.42. Appl. 19.6.41. Process for breaking petroleum emulsion.

D. W. Justis. U.S.P. 2,300,121, 27.10.42. Appl. 30.11.40. Deep well-pump for oil.

J. B. Clark. U.S.P. 2,300,206, 27.10.42. Appl. 30.10.41. Testing wells for the location of the lowermost point of water entry into the well.

F. E. Dana. U.S.P. 2,300,348, 27.10.42. Appl. 21.4.41. **Method for cleaning oil-wells.**

C. Lowery. U.S.P. 2,300,370, 27.10.42. Appl. 9.7.41. **Sucker-rod elevator.**
A. H. N.

Transport and Storage.

128.* Use of Soil Surface Potential in Locating Pipe-line Corrosion. O. C. Mudd. *Oil Gas J.*, 14.5.42, **41** (1) 50.—Voltage is set up in a corroding pipe-line in contact with one soil electrolyte in differing concentrations, or two different types of soil electrolyte, in contact themselves, in a manner comparable to its production in a dry-cell battery by contact of two different elements with one electrolyte. The pipe is analogous to the external circuit conductor between the anode and cathode of the dry cell, and although potentials developed are lower than those of batteries, they may be detected with a millivoltmeter. The similarity is traced in detail with the aid of diagrams.

The greatest corrosion takes place at the anodic section of the pipe, and the method described for the detection of corrosion activity is dependent on measurement at regular and frequent intervals along the pipe of (*a*) pipe to soil potentials by observing the potential drop between a metal bar in contact with the pipe and a non-polarizing electrode over the pipe axis, and (*b*) soil resistance by means of suitable equipment—*e.g.*, " Shepard Canes " or a " Soil Resistivity Megger." Corrections must be made for extraneously originating electrical influences—*e.g.*, due to magnetic storms or to nearby cathodic protection units, etc.

Results are plotted with respect to distance along the pipe, and give a fair indication of positions of probable corrosion activity. A crew of six men have surveyed an average of 3 miles per day of 10-in. line with 100-ft. intervals between surface contact points, including four soil-resistivity measurements per 100 ft. The author considers this technique an improvement over previous methods, since anodic sections are located within closer limits, and more details of electrolytic conditions can be determined in a given time. J. C.

129.* Electrical Charges Produces by Flowing Gasoline. S. S. Mackeown and V. Wouk. *Industr. Engng Chem.*, 1942, **34** (6), 659.—Measurements have been made of the magnitude of the electrostatic charges which can be produced when gasoline is pumped into a tank truck, and when gasoline is unloaded at a service station. It is shown that during filling, charges are formed which are capable of igniting a combustible mixture of gasoline vapour and air, but that during emptying insufficient electrostatic electricity is formed to represent a hazard. J. W. H.

130.* Bonding Pipe-lines as Protection Against Electrolysis. E. E. Claggett. *Petrol. Engr.*, 1942, **13** (10), 128.—The more important electrical influences which may affect an underground pipe-line are (*a*) stray or vagrant currents, (*b*) galvanic electricity, (*c*) static electricity, (*d*) magnetic fields. Various types of bonds or cables may be connected to the pipe-line to harmlessly discharge currents. Descriptions, including some diagrams and dimensions, are given of jumper bonds, which provide a current path round rubber gasket couplings, tie bonds, which equalize the potential between two underground structures, drainage bonds, which carry current to a place of safe discharge, pilot wires, which are used for potential test purposes, and " deadmen " (earth electrodes). Methods of installation are discussed, and a desirable type of fibre conduit for bond and pilot wires, used by the Southern California Gas Co., is described. J. C.

131.* When Should a Pipe-line be Coated ? S. Thayer. *Petrol. Engr*, 1942, **13** (10), 158.—A general article which emphasizes the difficulty of deciding on the basis of soil corrosiveness whether pipe-lines should be coated. Technical knowledge and practical experience are required for soil classification, but inaccuracies may still result from non-uniformity of the soil. A comparison of initial costs of coating with costs of repair for a pipe-line life of 30 years is made, and the conclusion is reached that pipe-lines should be coated not only in known corrosive areas, but also in doubtful areas. J. C.

Gas.

132.* Liquefaction of Natural Gas for Public Supply. Anon. *Engineer*, 1942, **173** (4506), 432.—A description is given of the plant of the East Ohio Gas Co. which supplies the city of Cleveland. Liquefaction of the natural gas was resorted to in order to cope with peak requirements.

The operation of the pilot plant installed at Cornwell disclosed that it was essential to remove all CO_2 and water vapour before liquefying, and that a stainless steel of 0·09% carbon and 3·5% nickel would be satisfactory for tank construction.

Details are given of the method of construction and type of plant necessary, and of the operation under service conditions. J. G. W.

133. Calcium Chloride Nomographs. D. S. Davis. *Industr. Engng Chem.*, 1942, **34** (11), 1393.—Nomograms are given which correlate the specific gravity, freezing point, and concentration for commercial calcium chloride brines containing sodium chloride. This data is of value in gas drying and refrigeration problems. J. W. H.

Polymerization and Alkylation.

134.* The Turbulent Spreading of a Water Jet. A. M. Binnie. *Engineering*, 1942, **153** (3929), 503.—Photographic experiments on the turbulent spreading of a water-jet into a large volume of fluid at rest are described. Various observed features are discussed and compared with theory. J. G. W.

135.* Catalytic Polymerization of Olefins in the Presence of Phosphoric Acid. A. Farkas and L. Farkas. *Industr. Engng Chem.*, 1942, **34** (6), 716.—The hydrogen atoms of the phosphoric acid were replaced by deuterium atoms, and the polymerization reaction of *iso*butene and other olefins investigated with this catalyst. From the results of the experiments it is shown that the polymerization proceeds with an exchange of hydrogen atoms between the catalyst and the butene. The reaction mechanisms proposed by various authors are discussed, and a modification of the Ipatieff mechanism is suggested. The principle involved is the formation of the monomer in two forms, one resulting from the transfer of a hydrogen atom to the catalyst and the other by a transfer from the catalyst to the monomer. These two forms combine together to make the polymer. J. W. H.

136. Patents on Polymerization and Alkylation. E. R. Kirn and N. Fragen. U.S.P. 2,301,052, 3.11.42. Appl. 8.10.38.—An increased yield is obtained in the process of converting normally gaseous olefin hydrocarbons into distillate lubricating oil if the olefin hydrocarbons are subjected in liquid phase to the action of a polymerizing catalyst. In this way the olefins are converted into heavier hydrocarbon polymers. Unreacted gaseous hydrocarbons are separated from these polymers, and the latter are fractionated, thus producing a distillate lubricating oil and a substantially non-volatile residue. The residue is subjected to pyrolytic decomposition regulated to regenerate olefinic hydrocarbons and to produce lubricating oils of intermediate viscosity. The products of decomposition are recycled to the fractionating zone and the polymerization process is modified by recycling at least a portion of the products of decomposition from the fractionating zone to the polymerizing process.

J. A. Chenicek and K. M. Brown. U.S.P. 2,301,615, 10.11.42. Appl. 15.10.41. Saturated branched-chain hydrocarbons are produced from normal paraffins and normal or branched-chain olefins by passing a normal paraffin charge and a lesser portion of recycled hydrocarbons, together with a small amount of hydrogen chloride, through an isomerization zone. A greater portion of the recycled hydrocarbons is passed through an aluminium chloride catalyst pick-up zone. Products from the isomerization and catalyst pick-up zone are combined with a separate stream of olefins in a proportion designed to maintain an excess of isoparaffin. The combined stream is passed through an alkylation zone, and the products are separated into alkylated hydrocarbons and unreacted hydrocarbons. At least a portion of the unreacted hydrocarbons are returned to the isomerization and catalyst pick-up zones. H. B. M.

Synthetic Products.

Progress in Rubber Chemistry. *Industr. Engng Chem.*, 1942, **34** (11), 1255–1371.—This issue contains a symposium on rubber which consists of twenty-six articles by different authors. Individual abstracts of the articles on synthetic rubber are given below. J. W. H.

137.* The Synthetic Programme.—*Résumé* of the Report of the Baruch Committee. *Industr. Engng Chem.*, 1942, **34** (11), 1256.—The production capacity of the various plants visualized in the present programme are given and compared with the estimated requirements for 1943 and 1944. Recommendations for the construction of further plants are made. The committee conclude that there is no serious conflict between the rubber and aviation fuel-production programmes. J. W. H.

138.* Progress of Butadiene Production. A. L. Elder. *Industr. Engng Chem.*, 1942, **34** (11), 1260.—At the moment the bottle-neck of the synthetic rubber programme is the production of butadiene, which is used in conjunction with styrene to produce Buna S, the synthetic rubber forming the largest portion of the production programme.

A review is given of a very large number of chemical syntheses which are available for the production of butadiene, and methods for its separation from associated substances are discussed. The following proved methods for the production of butadiene are described: (1) thermal cracking plants operating on light oils; (2) catalytic cracking plants to convert butane into butylene and thence to butadiene; (3) ethyl alcohol plants; (4) butylene glycol plants; (5) butyl alcohol plants. The butadiene requirements are 667,800 tons per annum, of which 107,800 tons will be obtained by thermal cracking, 340,000 tons from catalytic cracking and 220,000 tons from alcohol. J. W. H.

139.* Progress of Styrene Production. W. Dow. *Industr. Engng Chem.*, 1942, **34** (11), 1267.—A brief non-technical review is given of the Dow process for the conversion of ethylene to ethylbenzene which is dehydrogenated to yield monomeric styrene. J. W. H.

140.* Action of Organic Accelerators in Buna S. G. R. Vila. *Industr. Engng Chem.*, 1942, **34** (11), 1269.—Data are given on the effect of different rubber accelerators on the curing time, tensile strength, elasticity, elongation, hysteresis, and brittleness of vulcanized Buna S. It is concluded that the dithiocarbamates are the most suitable accelerators. Low sulphur contents give resistance to ageing, but slightly higher values are required for minimum hysteresis and brittleness. J. W. H.

141.* Effect of Carbon Blacks in Synthetic Tyre Compounds. B. S. Garvey and J. A. Fraser. *Industr. Engng Chem.*, 1942, **34** (11), 1277.—Twenty-four samples of carbon black, from various sources, representing ten distinct types have been blended in various proportions with a single synthetic rubber mix. After curing, the elongation, hardness, hysteresis, brittleness, and milling time were determined, and the data have been correlated for each individual black in terms of concentration. The data have also been arranged so that the effect of changing the type of black on the properties of a given tensile strength rubber can be appreciated. J. W. H.

142.* Perbunan Properties and Compounding. R. A. Moll, R. M. Howlett, and D. J. Buckley. *Industr. Engng Chem.*, 1942, **34** (11), 1284.—Data on the effect of different accelerators, softeners, and carbon blacks on the physical properties of vulcanized Perbunan rubber are given. It is shown that most of the common rubber accelerators are suitable for use with Perbunan, and that major changes in the physical properties can be made by varying the pigment loading and softener. Data are also given on the effect of oils and gasoline on various compounded Perbunan rubbers. J. W. H.

143.* Density Measurements of Synthetic Rubbers. L. A. Wood, N. Bekkedahl, and F. L. Roth. *Industr. Engng Chem.*, 1942, **34** (11), 1291.—A technique for the preparation of samples has been developed which enables consistent values of the densities of synthetic rubbers to be determined to an accuracy of 0·05%. Density

determinations on eighteen synthetic rubbers range from 0·93 to 1·6, compared with a value of 0·91 for natural rubber. J. W. H.

144.* Thermal Decomposition of Natural and Synthetic Rubber Stocks. I. B. Prettyman. *Industr. Engng Chem.*, 1942, **34** (11), 1294.—A method is described of measuring the chemical decomposition temperature of rubbers. It consists essentially of heating the sample below the surface of molten metal, and observing the samples, after 1 hour's heating, for the presence of blow-holes and cracks. Using this method, a comparison is made between natural rubber, hevea, reclaim, guayule, Buna, and Neoprene rubbers containing various accelerators, sulphur, and carbon-black contents. Buna and Neoprene rubbers had a much higher decomposition temperature than natural rubbers. Sulphur decreased the decomposition temperature, and certain types of black and accelerators increased the decomposition temperature. J. W. H.

145.* Effect of Petroleum Products on Neoprene Vulcanizates. D. F. Fraser. *Industr. Engng Chem.*, 1942, **34** (11), 1298.—Data obtained on the swelling of a sample of Neoprene G immersed in thirteen kerosenes of different types have been correlated by means of the diesel index (A.P.I. gravity × aniline point °F./100). It is found that the lower the diesel index the greater the degree of swelling which results. In the past it has been customary to test synthetic rubbers in a 15% benzene–kerosene blend at 60° C., and it is now proposed that these tests should be carried out in an oil of definite diesel index. J. W. H.

146.* Butyl Rubber Properties and Compounding. J. P. Haworth and F. P. Baldwin. *Industr. Engng Chem.*, 1942, **34** (11), 1301.—Butyl rubber, the elastic copolymer between *iso*butylene and small amounts of diolefin, is unique in the synthetic rubbers by virtue of the small amount of unsaturation present. This results in the vulcanizates being very resistant to oxidation. The rebound characteristics of butyl rubber are low at room temperature, but resemble natural rubber at 212° F. The low value at room temperature may be improved by slightly increasing the saturation. Butyl rubber can be readily handled in rubber factory equipment, the most important compounding factor being that sulphur vulcanization requires active accelerators of the thiuram type. Data on the effect of compounding on the physical properties are given, and measurements of the chemical resistance and swelling tendency have been made. J. W. H.

147.* The Processing Characteristics of Synthetic Tyre Rubber. B. S. Garvey, M. H. Whitlock, and J. A. Freese. *Industr. Engng Chem.*, 1942, **34** (11), 1309. Laboratory tests for evaluating the properties of crude and compounded rubbers are given, the relationships between laboratory and factory processing are discussed, and the processing characteristics of synthetic tyre rubber such as is being made under the U.S. Government programme are reviewed. J. W. H.

148.* Ebonite from Hycar OR-15. B. S. Garvey and D. V. Sarbach. *Industr. Engng Chem.*, 1942, **34** (11), 1312.—Ebonites made from Hycar OR-15 have physical properties equal to those of natural rubber and, in addition, have higher softening temperatures. This paper correlates changes in compounding composition with the physical properties of the ebonite produced. J. W. H.

149.* Volume Change of Hycar OR-15 Compounds on Immersion. A. E. Juve and B. S. Garvey. *Industr. Engng Chem.*, 1942, **34** (11), 1316.—The effect of immersion temperature, softeners, and size and shape of specimens on the swelling of Hycar OR-15 compounds in oil has been investigated. These are all shown to be important variables. J. W. H.

150.* Evaluation of Small Amounts of Synthetic Rubber. B. S. Garvey. *Industr. Engng Chem.*, 1942, **34** (11), 1320.—The design of a mill and the development of a testing technique are described, which enable a laboratory evaluation on 9 g. of a synthetic rubber to be made. The completed tests enable judgement to be made on

the milling behaviour at three temperatures, curing time, plasticity, tack, stress-strain, hardness, rebound, compression set, flexibility at low temperatures, brittle temperature, rapid flex hysteresis, and change in volume in five solvents. A number of comparisons have shown that conclusions based on these small-scale tests are in agreement with the data obtained on the ordinary laboratory experimental mill and testing technique which requires 200–500 g. of rubber. J. W. H.

151.* Unsaturation of Synthetic Rubberlike Materials. L. V. E. Cheyney and E. J. Kelley. *Industr. Engng Chem.*, 1942, **34** (11), 1323.—The unsaturation of three synthetic butadiene polymers has been determined by means of a modification of the Kamp–Wijs method. The reaction proceeds more slowly than with natural rubber, requiring 24 hrs. at 30° C. compared with 15 min. or less required for natural product. The iodine values obtained vary slightly with the solvent employed, but in general are within 85–90% of the theoretical values for straight-chain polymers. The difference is attributed to cross linkages. J. W. H.

152.* Effect of Aniline Point on the Swelling of Synthetic Rubbers. A. C. Hanson. *Industr. Engng Chem.*, 1942, **34** (11), 1326.—The investigation has been conducted with the object of determining the changes in volume to be expected with certain compounded materials in various oils of the hydraulic type used in recoil mechanisms. The increase in volume has been measured of three synthetic rubber compounds, containing Neoprene, Butyl, and Buna rubbers on immersion in eleven different oils at room temperature for periods up to 120 days. The Buna N compound gave the lowest values for swelling, and was the only rubber to show shrinkage.

A straight line is not obtained by plotting the log of the percentage increase in volume against aniline point of oils when a wide range of aniline points is covered. The inverse relation between the log% volume increase and aniline point only holds for volume increases up to 100%. J. W. H.

153.* Intermolecular Forces and Mechanical Behaviour of High Polymers. H. Mark. *Industr. Engng Chem.*, 1942, **34** (11), 1343.—The mechanical behaviour and intermolecular forces are correlated for three typical classes of high polymers—namely, rubbers, plastics, and fibres. A general conclusion is reached that there is no fundamental difference in structure between these types of compounds. It is shown that in order to possess any mechanical strength, the average degree of polymerization must have a minimum value of between 40 and 80, and that the proportionality between mechanical strength and chain length holds until a polymerization degree of 250 is reached. At this value the mechanical strength slowly increases until a polymer value of 700 is reached, when the ultimate strength is independent of the chain length. The shape of the polymer distribution curve (the mean value of which represents the degree of polymerization) does not appear to have any definite effect on the ultimate strength, except that constituents having a polymerization degree below 150 are definitely detrimental. The chemical nature of the monomer and the manner in which the individual chains are linked together have an important influence on the mechanical behaviour. High polymers possess a two-phase structure in which certain areas of a sample exhibit a high degree of internal organization (crystallites or micelles) and other areas which consist of disordered and randomly entangled chains (amorphous fractions). The internal structure of rubber is that of chains fitting badly into the lattice. Fine and well-fitting chains represent a fibrous structure, and intermediate structures are represented by plastics. These structures are considered from a thermodynamical point of view, and it is concluded that rubber-like properties can be obtained with all types of straight flexible chain polymers, provided that the intermolecular forces are balanced by a sufficient bulky construction so that the entropy of fusion exceeds a value of 0·9. J. W. H.

154.* Equation of State of Some Synthetic Rubbers. L. E. Peterson, R. L. Anthony, and E. Guth. *Industr. Engng Chem.*, 1942, **34** (11), 1349.—Stress-relative length data are given for two neoprene and one hycar rubber. From this data the thermodynamic equations of state for these rubbers have been calculated. The same equation of state

which characterizes natural rubber also describes in terms of relative length and temperature the retractive force exerted by those synthetic rubbers. J. W. H.

155.* Effect of Temperature and Pressure on Oxygen Pressure Ageing. A. M. Neal, H. G. Bimmerman, and J. R. Vincent. *Industr. Engng Chem.*, 1942, **34** (11), 1352.—The present ageing test for rubber vulcanizates is heating with oxygen at 70° C. and 300 lb. sq. in. and measuring the loss of tensile strength. Any attempt to shorten the time taken for this test by increasing the temperature or pressure will necessitate a revision of all ageing specification. This will involve an individual study of each stock and every cure, since no correlation exists between rate of ageing and change of temperature or pressure. These conclusions are supported by data for six stocks, which include two synthetics, at 70° and 80° C. and at ¼, 50, 150, and 300 lb. p.s.i. J. W. H.

156.* Vibration Properties of Rubberlike Materials. R. B. Stambaugh. *Industr. Engng Chem.*, 1942, **34** (11), 1358.—An electrical vibrator for determining the dynamic properties of rubbers is described. Measurements are made of the dynamic modulus, internal friction, and dynamic resilience over the temperature range − 30° to + 120° C. at frequencies of 30–100 cycles/sec. of natural and several synthetic rubbers. From this data it is concluded that : (1) the vibration modulus and resilience are independent of the frequency ; (2) the internal friction is inversely proportional to the frequency ; (3) the modulus decreases as the temperature rises, and curves for synthetic stocks at high temperatures are not very different to natural rubber at low temperatures ; (4) resilience rises linearly with temperature. Natural rubber shows a sharp transition at 25° C. ; (5) the internal friction-temperature relationship follows the same ex-potential law as the viscosity of liquids ; (6) the amplitude of the vibration has a large inverse effect on the modulus and friction. J. W. H.

157.* Theory of Rubber Elasticity for Development of Synthetic Rubbers. H. M. James and E. Guth. *Industr. Engng Chem.*, 1942, **34** (11), 1365.—An elasticity theory is developed from thermodynamical considerations. The theory shows that for high extensions only the contracting force changes its dependency upon extension. The internal pressure remains practically the same. These effects result in the characteristic S-shaped stress–strain curve which is typical of rubbers. It has been shown that this -shaped curve is independent of crystallization. J. W. H.

158.* Motion Picture Study of Rubber Lattices. F. F. Lucas. *Industr. Engng Chem.*, 1942, **34** (11), 1371.—An ultra-violet microscope technique has been developed for the examination of colloidal rubber dispersions. Micrographs and time study photographs are given for Balata and Hevea lattices. It is shown that a common element of any rubber structure is a primary particle with one or more satellites gyrating round it. Chains form and break up, and others form in constantly changing pattern. In the case of Buna and neoprene lattices the particles are small and uniform, and the motions are faster than natural rubber. Some lattices appear light-sensitive when much diluted and the particles gradually disappear. J. W. H.

159.* Coal in the Manufacture of Synthetic Rubber. H. L. Fisher. *Industr. Engng Chem.*, 1942, **34** (11), 1382.—The manufacture of the chief synthetic rubbers by the method of emulsifying the ingredients is described, and the substances from coal used in the processing and compounding of synthetic rubbers are discussed. Flow-sheets for the manufacture of several synthetic rubbers are given. J. W. H.

160.* Coal as a Source Material for the Plastics Industry. R. L. Wakeman and B. H. Weil. *Industr. Engng Chem.*, 1942, **34** (11), 1387.—The competition which the petroleum industry will offer to the coal industry in the production of plastics and synthetic rubber is discussed. J. W. H.

Refining and Refinery Plant.

161.* Conversion of Gasoline Plants to Increase *iso*Butane Extraction. W. L. Rifenberick. *Petrol. Engr*, 1942, **13** (10), 150.—Among possible methods suggested for

modifying gasoline plant operation to increase the extraction of isobutane and propane are :—

(1) Increased oil circulation.
(2) Reduced oil temperature.
(3) Increased absorption pressure.

(1) is an inexpensive method for plants having excess capacity in absorbers, coolers, etc.

(2) can be accomplished in several ways—for example, by reducing the load on the cooling towers, or by some form of refrigeration. A flow-sheet of a " vacuum refrigeration " unit is shown. In the case of high-pressure absorption plant it is essential to cool the wet gas as well as the lean oil.

(3) is applicable in the case of a few low pressure plants.

These methods, or any others used, must be considered in relation to the rest of the plant, so that the overall effect is beneficial.

Methods of handling, after additional extraction has been made, are briefly described and simplified flow diagrams given. J. C.

162. Influence of Sulphur Compounds on Octane Number and Lead Susceptibility of Gasoline. J. G. Ryan. *Industr. Engng Chem.*, 1942, **34** (7), 824.—The effect has been studied of some eighteen different sulphur compounds, representing eight different types, on the octane number and lead response of a reformed gasoline. The effect of these compounds on the octane number varies with the size and structure of the hydrocarbon portion of the molecule as well as the sulphur type. These data have been correlated in the form of a general equation for sulphur types which enables the effect of desulphurization on the octane number and lead response to be estimated from the group sulphur analyses. J. W. H.

163. How Refiners Conserve Critical Materials. Anon. *Chem. Met. Eng.*, October 1942, **49** (10), 93–94.—The paper summarizes several booklets on " War-time Plant Design " issued by the Office of the Petroleum Co-ordinator for War, on the saving of strategic construction materials through substitution in petroleum refineries. The suggestions deal with steel plates, boilers, elimination of explosion-proof motors by using outdoor installation, substituting concrete or wood for steel and glass for metal windows, or one type of steel for another less easily procurable, etc. In building construction, permanent trolley systems for handling heavy equipment are being omitted and, instead, space is being provided for the access of crawler planes or for temporary rigging. Some convenience platforms are being eliminated and others reduced in size. Reinforced concrete and wood are being employed wherever practicable instead of steel. For example, wood is being used as far as possible for stringers and treads of stairways, for ladders, railings, platform floorings, and some framing. Massive concrete without reinforcement is being used where possible as in foundations and slabs on the ground, or with minimum reinforcement. As far as possible, buildings are being constructed with brick walls, with wood-roof beams or trusses, with plank roofs and built-up roofing. Wood is being used for door-frames, doors, and sashes. An interesting idea for two-storey structures is to use reinforced concrete for the lower storey and heavy timber-mill construction for the upper storey.

A variety of other metal-saving suggestions has also been incorporated in the specifications, including the use of cement-asbestos sheet material instead of galvanized and coated iron, the elimination of galvanized nails, and metal lath, and the use of coated ferrous materials so far as possible without galvanizing for screening, flashing, and for down-spouts. Terra-cotta and concrete are being substituted whenever possible for metal pipes for sewer lines, and non-metallic coated materials for conduits. Instead of conduits, non-metallic sheathed cables are being employed where practicable, together with electric-light fixtures eliminating as much metal as possible. Cast iron, rather than copper, is being used for heating coils and convectors for enclosed areas.

The use of enamelled bubble caps instead of cast iron caps is advocated. Instead of large stress relieving furnaces being used, it is suggested that equipment should be stress-relieved by the manufacturer in small components and shipped ready for erection. Change in designs is suggested. A. H. N.

164. Electronic Liquid Level Indicator. S. C. Coroniti. *Rev. Sci. Instrum.*, 1942, **13** (11), 484.—Data for the design of, and a description of a liquid level indicator are given. This instrument is suitable for use with conducting and non-conducting liquids. The principle on which this piece of apparatus depends is the variation of capacitance caused by the liquid which detunes a resonance circuit resulting in a change of plate current in an oscillator tube. J. W. H.

165. Patents on Refining and Refinery Plant. H. E. Drennan. U.S.P. 2,300,877, 3.11.42. Appl. 12.8.40. A hydrocarbon fraction containing mercaptan sulphur and colour- and gum-forming constituents is rendered sweet by desulphurizing it by contact with a metal oxide capable of reacting with the mercaptan sulphur to form the corresponding sulphide. The reaction is carried out at a temperature between 500° and 850° F., and afterwards the hot effluent is mixed with hydrogen and the mixture is passed over a hydrogen sulphide-poisonable hydrogenation catalyst to hydrogenate the unstable constituents, which are responsible for colour- and gum-instability.

B. T. Brooks and F. W. Schumacher. U.S.P. 2,301,246, 10.11.42. Appl. 24.8.40. Waxy constituents are removed from a feed-oil by mixing with it a quantity of an olefin oxide having four to six carbon atoms in the molecule. The mixture is chilled to a temperature at which the waxy constituents precipitate. These are removed from the dewaxed oil, and so is the olefin oxide.

J. B. Maxwell and K. E. Thorp. U.S.P. 2,301,304, 10.11.42. Appl. 30.11.40. Process for the removal of hydrocarbon constituents having three and less carbon atoms in the molecule from petroleum feed-oils boiling below 250° F. The feed-oil is introduced in liquid state into the top of a stabilization zone and passed down through the zone under conditions in which the temperature increases in the direction of flow of the feed-oil. Reflux is provided in the stabilization zone by withdrawing at least one intermediate stream, cooling it, and returning it to the stabilization zone. Hydrocarbon constituents containing three or less carbon atoms in the molecule are removed overhead, and heat is provided to the stabilization zone by withdrawing a bottoms stream, heating it and returning it.

S. C. Carney. U.S.P. 2,301,520, 10.11.42. Appl. 11.6.40. High-pressure well distillates are contacted with a desorbing vapour to remove essentially only methane and retain the other volatile materials heavier than methane. The liquid effluent from the desorption zone is fractionated to obtain a stabilized well distillate and a vaporous overhead. The latter is fractionated to obtain natural gasoline and a second vaporous overhead. The second vaporous overhead is cooled to obtain as a condensate a polymerization feed stock. Unpolymerized vapour is passed back to the methane desorption zone as a desorbing vapour.

W. A. Schulze and G. H. Short. U.S.P. 2,301,588, 10.11.42. Appl. 31.8.40. Carbonyl sulphide can be removed from hydrocarbon fluids subsequent to treatment for removal of hydrogen sulphide and mercaptans by contacting them with a reagent consisting of an adsorbent carrier impregnated with a solution of a lead salt and monoethanolamine.

P. Washburn. U.S.P. 2,301,595, 10.11.42. Appl. 2.9.39. Bitumens and/or crude petroleum are treated in such a way that all the raw material is converted into a mist. The diffusing moisture in the form of mist is combined with the petroleum mist, and all the mist particles are afterwards frozen. The frozen particles are broken up and subsequently subjected to melting temperatures.

W. A. Proell and R. S. McClaughry. U.S.P. 2,301,794, 10.11.42. Appl. 6.3.40. The stability to oxidation of a viscous petroleum oil is increased by treating the oil with a gas containing free oxygen. The oxidized oil is neutralized by treatment with an alkali metal hydroxide, and afterwards chemically reduced by treatment with at least one reducing agent.

R. E. Burk and E. C. Hughes. U.S.P. 2,301,802, 10.11.42. Appl. 9.9.39. Hydrocarbons are desulphurized by contacting them without the addition of free hydrogen with a 20 : 80 mol.% gel precipitated chromium and aluminium oxide catalyst at a temperature of about 575° F.

R. K. Stratford and G. W. Gurd. U.S.P. 2,302,383, 17.11.42. Appl. 7.12.38. Separation of a hydrocarbon fraction of the class of naphtha, kerosene, and light gas oil into its relatively more paraffinic and relatively more aromatic constituents. The hydrocarbon fraction is extracted with a solvent consisting essentially of a substance selected from the class of dihydric alcohols characterized by having at least two ether groups.

E. M. Dons and O. G. Mauro. U.S.P. 2,302,430, 17.11.42. Appl. 2.1.42. Continuous process for dewaxing oil and selectively de-oiling the wax. The wax is first precipitated in a liquid solution of the oil and a selective dewaxing solvent in a precipitating zone. In this way clusters of coalesced wax crystals are formed with portions of the oil solution trapped in the wax. A stream of the liquid solution and wax is passed into a settling zone, thus causing the wax to separate from free portions of the liquid oil solution, while allowing the wax to coalesce and trap portions of the oil solution. A stream of dewaxed oil solution is discharged from the settling zone and passed to a countercurrent de-oiling zone, through which is transmitted a continuous stream of selective de-oiling solvent. In this way the counterflowing de-oiling solution is caused to remove and dissolve portions of the solution carried by the wax. Afterwards the wax is discharged from the stream of selective de-oiling solvent and the coalesced wax subjected to forcible disintegrating operations while it is in transit from the precipitating zone to the de-oiling zone to liberate trapped oil solution. H. B. M.

Fire Prevention.

166. Guarding against the Flammable Liquid Fire Hazard. G. L. Griffin. *Industr. Engng Chem.*, 1942, **34** (6), 664.—The use of CO_2 in the suppression of fires depends on the rapid reduction of the O_2 content of the air from 21 to 14%. Descriptions are given of typical installations employing CO_2 for fire-fighting, including the use of automatic equipment. J. W. H.

Chemistry and Physics of Hydrocarbons.

167. Photochemistry of *iso*Butane. I. W. F. Keffer and J. P. Howe. *J. Amer. Chem. Soc.*, 1942, **64**, 1–7.—This work is an attempt to determine the mechanism of the gas-phase photochemical polymerization of *iso*butane, while observing generally the direct action of light on the molecule. Approximately monochromatic radiation from the aluminium spark was used, and both decomposition and polymerization occurred. From the analyses of the products, quantum yields were calculated. The effects of light intensity and the presence of nitrogen or oxygen are also reported. Absence of methyl-acetylene showed that the reaction was not analogous to the effect of light on ethylene.

From their results the authors discuss the mechanism of the reaction. A free radical mechanism is required for some of the processes, and, in addition, is capable of accounting for all the observed processes. E. H. W.

168. Alkylation of Paraffins at Low Temperatures in the Presence of Aluminium Chloride. H. Pines, A. V. Grosse, and V. N. Ipatieff. *J. Amer. chem. Soc.*, 1942, **64**, 33–36.—A description is given of the reactions between *iso*butane and (*a*) *n*-butene, (*b*) propene at low temperatures.

Reaction (*a*) was carried out at −35° C. and 1 atm. pressure, the liquid products contained more than 60% octanes and 12% dodecanes. In the octane fraction, 2 : 2 : 4-, 2 : 2 : 3-, and 2 : 3 : 4-trimethylpentane, together with 2 : 5-dimethylhexane, were identified.

In reaction (*b*), carried out at −30° C. and 1 atm. pressure, 42% of heptanes and 20% of decanes were produced. The heptane fraction consisted mainly of 2 : 3-dimethylpentane, together with 2 : 4-dimethylpentane.

The reaction products in these experiments were identified by their Raman spectra. E. H. W.

169. Structure and Absorption Spectra. III. Normal Conjugated Dienes. R. B. Woodward. *J. Amer. chem. Soc.*, 1942, **64**, 72–75.—The band maxima in the absorp-

tion spectra of normal conjugated dienes are calculated by these authors with the use of simple substitutive and positional shifts. Examples are given of these generalizations and analogies between the diene chromophore and α-β-unsaturated ketone chromophore are pointed out. E. H. W.

170. **Structure of Vinyl Polymers. XII. The Polymer of Methyl Isopropenyl Ketone.** C. S. Marvel, E. H. Riddle and J. O. Corner. *J. Amer. chem. Soc.*, 1942, **64**, 92–94.—The structure of the polymer of methyl *iso*propenyl ketone is shown to be of the "head-to-tail" type. E. H. W.

171. **Solubility of Carcenogenic and Related Hydrocarbons in Water.** W. W. Davis, M. E. Krahl, and G. H. A. Clowes. *J. Amer. chem. Soc.*, 1942, **64**, 108–110.—The approximate solubility in water at 27° C. for thirty-one hydrocarbons has been determined by the nephelometric method (Davis and Parker, *J. Amer. chem. Soc.*, 1942, **64**, 101–107). Thirteen of the hydrocarbons are carcenogenic, two of doubtful activity, fourteen non-carcenogenic (two of the hydrocarbons not being classified). E. H. W.

172. **Statistics of Intramolecular Aldol Condensations in Unsaturated Ketone Polymers.** Note by P. J. Flory. *J. Amer. chem. Soc.*, 1942, **64**, 177–179.—The author gives a correction to a previous paper (*J. Amer. chem. Soc.*, 1939, **61**, 1518), when he erroneously included as an example the intramolecular aldol condensation of the polymer of methyl vinyl ketone. He now gives a revised statistical treatment for this case. E. H. W.

173. **Some Heat Capacity Data for Gaseous 2 : 2 : 4-Trimethylpentane.** Note by M. Kiperash and G. S. Parks. *J. Amer. chem. Soc.*, 1942, **64**, 179.—Five determinations of the heat capacity of gaseous 2 : 2 : 4-trimethylpentane are reported and compared with a value given by Pitzer (*J. Amer. chem. Soc.*, 1940, **62**, 1224). Calculated results using Pitzer's empirical equation, and two series of C_p^0 values for the gas at zero pressure are also given. E. H. W.

174. **Kinetics of Hydrogen Consumption, Oxygen Elimination, and Liquefaction in Coal Hydrogenation. Nature of the Catalytic Reactions.** H. H. Storch, C. O. Hawk, and W. E. O'Neill. *J. Amer. chem. Soc.*, 1942, **64**, 230–236.—The paper reports on a series of experiments carried out on a bituminous coal at various temperatures and contact times in the presence and absence of a catalyst. The results are tabulated and there is a discussion on their interpretation. Oxygen elimination and liquefaction in the presence of tetrahydronaphthalene were shown to be non-catalytic, but hydrogen absorption increased with increasing amounts of catalyst. It was also shown that the nature of the rate-determining step varied with the temperature. E. H. W.

175. **Intramolecular Condensations in Polymers.** F. T. Wall. *J. Amer. chem. Soc.*, 1942, **64**, 269–273.—The amount of oxygen remaining in a polymer after condensation on heating has been calculated statistically. The cases considered are infinitely long "head-to-tail," random, and "head-to-head–tail-to-tail" polymers. The results for pure polymers are then extended to co-polymers. E. H. W.

176. **Viscosities of Solutions of Polyvinyl Chloride.** D. J. Mead and R. M. Fuoss. *J. Amer. chem. Soc.*, 1942, **64**, 277–282.—In this study, vinyl chloride polymers prepared in different ways were used, and results are given on both fractionated and unfractionated samples, dissolved in various solvents. The absolute viscosity of the solutions decreased with increasing pressure and this effect was eliminated by extrapolating to zero pressure, or more quickly by the use of an empirical correction formula.

In general, the viscosities of solvents and solutions remained essentially constant with time, but the use of *cyclo*hexanone is recommended for these polymers.

The equivalent viscosity (λ) is a linear function of concentration, and with the solvents used it varied only slightly. With either increasing time or temperature λ showed only small increases.

An empirical formula is derived which permits determination of the limiting equivalent viscosity (λ_0) for zero concentrations from a single viscosity measurement.

From determinations of the sedimentation and diffusion constants of a given sample of polymer, the authors calculate an absolute molecular weight, and hence derive a preliminary value for the Staudinger constant for polyvinyl polymers. E. H. W.

177. The Effect of Structure on Reactivity: Nuclear Substitution of Benzene Derivatives. H. F. McDuffie, Jr., and G. Dougherty. *J. Amer. chem. Soc.*, 1942, **64**, 297–299.—To obtain further information on the effect of structure on the rates of nuclear substitution, the Friedel–Crafts reaction of acetyl chloride with benzene derivatives in the presence of anhydrous aluminium chloride has been used. By this means the relative reactivities of various mono-, di-, and tri-substituted benzene derivatives have been obtained. With mono-substituted benzene derivatives the results obtained correlate well with the available results for nitration, the substituent constants presented by Hammett, and the rates calculated from the dipole moments of the mono-substituted benzenes. E. H. W.

178. Carboxylation. I. The Photochemical and Peroxide-catalysed Reactions of Oxalyl Chloride with Paraffin Hydrocarbons. M. S. Kharash and H. C. Brown. *J. Amer. chem. Soc.*, 1942, **64**, 329–333.—In the presence of light, oxalyl chloride was found to react with paraffin hydrocarbons forming acid chlorides; thus there is a direct substitution of hydrogen by the —COCl group. The following hydrocarbons underwent this photolysis: *cyclo*hexane, methyl*cyclo*hexane, chlor*cyclo*hexane, methyl*cyclo*pentane, *n*-pentane, *n*-heptane, and *iso*-octane. Organic peroxides catalyse a similar dark reaction between paraffin hydrocarbons and oxalyl chloride. The authors postulate a chain mechanism for the reaction, and this is supported by the failure to detect keto-acid chlorides from the action of oxalyl chloride on pyruvic acid, benzoyl formic acid, and benzoyl peroxide. E. H. W.

179. Carboxylation. II. The Reactions of Oxalyl Chloride with Unsaturated Hydrocarbons. M. S. Kharash, S. S. Kane, and H. C. Brown. *J. Amer. chem. Soc.*, 1942, **64**, 333–334.—This work continues that reported in the preceding abstract. Neither light nor peroxides had any apparent effect on the action of oxalyl chloride with unsaturated compounds. Gentle refluxing of the mixture was sufficient to bring about a reaction with certain olefinic derivatives.

With 1 : 1-diphenylethylene, styrene, α-methylstyrene, and 1-methyl*cyclo*hexane, the chloroformyl group replaced a hydrogen atom attached to one of the doubly-bonded carbon atoms. Phenyl acetylene, the only member of the acetylene series tested, reacted somewhat differently. Under the given conditions, *cyclo*hexane, stilbene, trimethylethylene, cetene-1, octene-1, and 1 : 2-dichloroethylene did not react with oxalyl chloride. The factors influencing the rate of the reactions and the yields were taken as an indication of a polar mechanism for the reactions. E. H. W.

180. The Partial Reduction of Acetylenes to Olefins using an Iron Catalyst. II. Enyne and Dienyne Reduction. A. F. Thompson, Jr., and E. N. Shaw. *J. Amer. chem. Soc.*, 1942, **64**, 363–366.—Continuing work on Paul and Hilly's iron hydrogenation catalyst, it is now stated that it is not completely specific for the carbon–carbon triple bond, but that, from the evidence available, there is a marked decrease in the rate of reduction of the olefin as compared with the acetylene.

The hydrogenation of acetylenes RC ≡ CH and RC ≡ CR, enynes RC ≡ C–CR = CHR and dienynes RCH = C(R)–C ≡ C–C(R) = CHR, using this catalyst, are reported. It is proposed to study the mechanism of the reduction of enyne and dienyne systems using this catalyst. E. H. W.

181. Trans. 2 : 2 : 6-Trimethyl*cyclo*hexane Carboxylic Acid. A Second Solid Naphthenic Acid from Californian Petroleum. B. Shive, J. Horeczy, G. Wash, and H. L. Lochte. *J. Amer. chem. Soc.*, 1942, **64**, 385–391.—The isolation of a new acid $C_{10}H_{18}O_2$ from the unesterifiable naphthenic acids in Californian petroleum has been previously reported (*J. Amer. chem. Soc.*, 1939, **61**, 2448). The deduction of the structure of this acid as trans 2 : 2 : 6-trimethyl*cyclo*hexane carboxylic acid, together with a synthesis and preparation of derivatives, is now described.

This secondary acid, its methyl ester, and amide, behave as highly hindered com-

pounds; the Whitmore method for distinguishing types of aliphatic acids failed with this acid. E. H. W.

182. Some Observations on the Oxidation and Determination of the Molecular Weight of Polynuclear Aromatic Compounds. W. P. Campbell, M. D. Soffer, and T. R. Steadman. *J. Amer. chem. Soc.*, 1942, **64**, 425–428.—The nitric acid oxidation of some aromatic hydrocarbons and derivatives is described. The titration of several hydrocarbon picrates is reported and the advantages of this method of analysis are pointed out. E. H. W.

183. The Dielectric Behaviour, Supercooling and Vitrification of certain Chlorobutanes and Chloropentanes. A. Turkevich and C. P. Smyth. *J. Amer. chem. Soc.*, 1942, **64**, 737–745.—The measurements of the dielectric constants and specific conductances at frequences of 50, 5, and 0·5 kilocycles on *i*-butyl chloride, *i*-amyl-chloride, *t*-amyl chloride, and 1 : 2-dichloro*iso*butane are reported. Examination was made visually and with the polarizing microscope down to liquid air temperatures, and also by temperature time curves. A detailed description of the low-temperature behaviour of each of the substances examined is given. 1 : 2-Dichloro*iso*butane showed only a very slight tendency to crystallize, an explanation being put forward to explain this. The tendencies for the compounds considered to crystallize or vitrify are compared with other hydrocarbons, and reasons are suggested for their behaviour. E. H. W.

184. The Preparation and Isolation of 4-Methyl-1 : 3-Pentadiene. G. B. Bachman and C. B. Goebel. *J. Amer. chem. Soc.*, 1942, **64**, 787–790.—Dehydration of 4-methyl-2 : 4-pentanediol gives a mixture of 4-methyl- and 2-methyl-1 : 3-pentadienes, the latter predominating. Separation of the two had not been previously achieved by physical means. The isolation of the desired hydrocarbon in 23% yields is now described, being accomplished by choice of conditions of temperature, solvents, and catalyst. The boiling point, density, and refractive index of the diene have been carefully determined. E. H. W.

185. A Synthesis of 4 : 10-Ace-1 : 2-Benzanthrazene Utilizing Δ^4-Tetrahydrophthalic Anhydride. L. F. Fieser and F. C. Novello. *J. Amer. chem. Soc.*, 1942, **64**, 802–809.—The use of Δ^4-tetrahydrophthalic anhydride for various syntheses is described. Carcenogenic derivatives of 1 : 2-benzanthrazene are considered, and in particular a synthesis of 4 : 10-ace-1 : 2-benzanthrazene is described.

The hydrocarbon obtained appeared to be somewhat purer by its higher melting point than two products from earlier preparations.

The previous samples had shown a high carcenogenic activity. The new preparation is being assayed. E. H. W.

186. Conjugated Diolefins by Double Bond Displacement. A. L. Henne and A. Turk. *J. Amer. chem. Soc.*, 1942, **64**, 826–828.—In a preparation of dimethallyl it was observed that 10% of the conjugated di-*iso*octyl was produced. Experiments were conducted to find the most favourable conditions for the production of the conjugated isomer. From the results, seven 1 : 5-dienes were passed through a long column of heated activated alumina. Conclusions reached were: (*a*) terminal positions of the double bond rearranged most easily; there is some difficulty when one of the double bonds is in the body of the molecule and the rearrangement is most difficult to accomplish when both of the double bonds are so "buried." (*b*) The presence in the 2-position of a side methyl radicle facilitates the shift. (*c*) The direction of shift with symmetrical carbon skeletons is towards the centre of the molecule. (*d*) The tendency to shift past a side methyl radicle predominates over the tendency to shift towards the centre of the molecule. (*e*) Lastly, some pyrolysis or shift of carbon structure was observed in all cases of hot alumina treatment. E. H. W.

187. The Study of the Action of an Aluminium-Aluminium Chloride Catalyst in Friedel–Crafts Reactions. Benzoylation. O. Grummitt and E. N. Case. *J. Amer. chem. Soc.*, 1942, **64**, 878–880.—Hall and Nash (*J. Inst. Petrol.*, 1939, **23**, 679) found that the

presence of aluminium retarded the activity of an aluminium chloride catalyst in the polymerization of ethylene.

The benzoylation of benzene by benzoyl chloride to form benzophenone in the presence of an aluminium–aluminium chloride catalyst is described in this paper, as a beginning of a study of typical Friedel–Crafts reactions using this catalyst.

Some reduction reactions occurred, being caused by hydrogen from the action of the aluminium on the hydrogen chloride, the latter being produced in the benzoylation. Evidence is produced to support this suggested reaction, which the authors say may partly explain Hall and Nash's observation. E. H.W.

188. A Quantum Mechanical Investigation of the Orientation of Substituents in Aromatic Molecules. G. W. Wheland. *J. Amer. chem. Soc.*, 1942, **64**, 900–908.—A new treatment based on the molecular orbital method is given, which differs from previous ones which gave attention to the charge distributions on the isolated molecules. Substitutions by electrophilic, nucleophilic, and radical reagents are treated from a unified point of view.

The calculated effects are of the correct order of magnitude for both the rates of substitution and the values of resonance moments. E. H. W.

189. The Nitrogen Compounds in Petroleum Distillates. XXIII. The Structure of a $C_{16}H_{25}N$ base from California Petroleum. B. Shive, S. M. Roberts, R. I. Mahan, and J. R. Bailey. *J. Amer. chem. Soc.*, 1942, **64**, 909–912.—The structure of the $C_{16}H_{25}N$ base isolated from Californian Petroleum by Bailey and Thompson (*J. Amer. chem. Soc.*, 1931, **53**, 1002) has now been shown to be 2-(2 : 2 : 6-trimethyl*cyclo*hexyl)-4 : 6-dimethylpyridine. For the first time a structural correlation between a naphthenic acid and naphthene base from petroleum has been established. E. H. W.

190. Kinetics of Caseous Reactions by Means of the Mass Spectrometer. The Thermal Decomposition of Dimethyl Ether and Acetaldehyde. E. Leifer and H. C. Urey. *J. Amer. chem. Soc.*, 1942, **64**, 994–1001.—A new use for the mass spectrometer is given by which the course of kinetic reactions may be followed. Advantages claimed for the method are: direct identification and concentration measurements of all stable substances involved, including intermediates. An investigation by this method was made on the thermal decompositions of acetaldehyde and dimethyl ether; in the latter case ethane was detected and a chain mechanism suggested for the reaction. E. H. W.

191.* Physical Constants of Low Boiling-Point Hydrocarbons. R. Matteson and W. S. Hanna. *Oil Gas J.*, 12.5.42, **41** (2), 33.—A valuable compilation in compact, tabular form of the physical constants of the lower paraffins, olefines, aromatics, and miscellaneous compounds. Constants included are molecular weight, carbon–hydrogen ratio, melting point, boiling point, critical constants, liquid density, A.P.I. gravity and pounds per gallon, gas density, gas-law deviation factor, specific heat and ratio of specific heats, heats of combustion, vaporization and fusion, air required for combustion, inflammable limits, refractive index, aniline point, and octane number.

A bibliography is given of the literature from which the figures are quoted. J. C.

192.* Desulphurizing Properties of Zinc Hydroxide. K. A. Musatov and L. G. Krymova. *Oil Gas J.*, 21.5.42, **41** (2), 40.—Translated and edited from the original in the *Journal of Applied Chemistry, U.S.S.R.*, this article is of interest in view of the present necessity for obtaining the highest possible lead response in motor and aviation gasoline.

Zinc hydroxide was shown to be an effective reagent in removing sulphur from light distillates. Batch experiments were carried out by shaking the distillate with ground hydroxide and continuous experiments by passing the vapour through a glass tube packed with granular hydroxide and heated in an electric furnace. The temperature ranged from 20° to 500° C., and maximum desulphurization was obtained at 350° to 370° C.

It was shown that zinc hydroxide adsorbs resins, whilst its desulphurization activity decreases with increase of sulphur content in the original distillate. J. C.

193. The Solubility of Gases in Liquids. A. E. Markham and K. A. Kobe. *Chem. Rev.*, 1941 (3), 519.—An extensive review of the subject is given, which includes methods of measurement and solubility relationships in addition to extensive references to sources of solubility data for fifty-four different gases in various solvents, including many hydrocarbons. J. W. H.

194. Thermal Reaction of Ethylene with Acetylene. E. A. Naragon, R. E. Burk, and H. P. Lankelma. *Industr. Engng Chem.*, 1942, **34**, 355.—The synthesis of butadiene by the interaction of ethylene and acetylene at 610° C. at atmospheric pressure has been studied. It is concluded that, in addition to the direct combination which occurs to form butadiene, the side reactions involved are the dimerization of ethylene and acetylene to form primary products from which gaseous and liquid secondary products result. In these liquid products diolefins and aromatics are prominent. J. W. H.

195. Nomographs for Minimum Reflux Ratio and Theoretical Plates for Separation of Binary Mixtures. E. H. Smoker. *Industr. Engng Chem.*, 1942, **34**, 509.—The equations for the calculation of minimum reflux ratio and number of theoretical plates are frequently used in distillation problems, and the nomographs presented enable their immediate solution to be obtained. J. W. H.

196.* Interconversions of Binary Compositions by Simple Graphical Methods. K. H. Sun and A. Silverman. *Industr. Engng Chem.*, 1942, **34** (6), 682.—Graphical methods are given for the interconversion of mol. weight, and volume fractions for binary mixtures which enable the conversion to be made rapidly when these become routine operations. J. W. H.

197.* Molecular Refraction—Critical Temperature Nomograph. D. S. Davis. *Industr. Engng Chem.*, 1942, **34** (6), 689.—A nomograph is given which enables the critical temperature to be estimated from the molecular refraction. The chart given is applicable to hydrocarbons, acids, alcohols, esters, ethers, and nitriles. J. W. H.

198.* Liquid-liquid Extraction Data. D. F. Othmer and P. E. Tobias. *Industr. Engng Chem.*, 1942, **34** (6), 690.—Data are given for the systems toluene-*n*-heptane–acetic acid–water, and for ternary systems of acetaldehyde and water with the solvents benzene, toluene, furfural, and *n*-amyl alcohol. The data on the toluene systems are given with the object of extracting toluene from its associated paraffinic hydrocarbons. The application of the synthetic method for the determination of tie lines is discussed, and a graphical method is given for the application of the lever rule to these data. J. W. H.

199.* Tie Line Correlation. D. F. Othmer and P. E. Tobias. *Industr. Engng Chem.*, 1942, **34** (6), 693.—From theoretical considerations a general equation for the correlation of tie-line data has been derived which results in a straight line plot of log. log $(1 - a_1)/a_1$ against log $(1 - b_2)/b_2$, when a and b are the solvent composition of the solvent and diluent phases. Employing this method of plotting the data, a number of ternary systems have been correlated. J. W. H.

200.* Partial Pressures of Ternary Liquid Systems and the Prediction of Tie Lines. D. F. Othmer and P. E. Tobias. *Industr. Engng Chem.*, 1942, **34** (6), 696.—An equation is given relating the partial pressure of the solute in a ternary system to the composition. By the use of this equation the tie lines for a ternary system may be predicted from partial-pressure data of the two binary systems forming the ternary system. The value of the method is illustrated by comparison of the determined and calculated determined phase distribution data for the following third components in benzene–water systems: acetic acid, acetaldehyde, ethanol, and for the systems *cyclo*hexane–ethanol–water and chloroform–acetone–water. J. W. H.

201.* Liquid–Liquid Extraction in a Perforated Plate Tower. R. E. Treybal and F. E. Dumoulin. *Industr. Engng Chem.*, 1942, **34** (6), 709.—A 3·56-diameter tower has been

operated for the extraction of benzoic acid from toluene by water, the toluene being in the disperse phase, with the object of examining the effect of plate spacing on extraction tower performance. Data has been obtained for 3, 6, and 9-inch plate spacings. The H.T.U. are shown to be almost identical for 6- and 9-inch spacing, but are halved for 3-inch spacing. The permissible throughput for a given extraction coefficient (lb. moles acid transferred/hr./cu. ft. per log mean conc. gradient) is almost identical for 6- and 9-inch spacings, but is halved for 3-inch spacing. It is therefore concluded that the most useful plate spacing is 6 inches. J. W. H.

202.* Thermodynamic Properties of *n*-Pentane. B. H. Sage and W. N. Lacey. *Industr. Engng Chem.*, 1942, **34** (6), 731.—The specific volume of *n*-pentane has been determined over the temperature range 100–460° F. and at pressures up to 10,000 ib. sq. in. The vapour pressure was also determined over this temperature range and the enthalpy-pressure coefficients, isothermal enthalpy changes, and fugacity calculated. The results are presented in graphical and tabular form. J. W. H.

203.* Isolation of Sulphur Compounds from California Straight-Run Gasoline. O. L. Polly, A. C. Byrns, and W. E. Bradley. *Industr. Engng Chem.*, 1942, **34** (6), 755.—The distribution of sulphur with boiling point is given for a sample of Californian gasoline, and it is shown that each of the regions of high sulphur content corresponds to the boiling point of a thiophane. These thiophanes have been isolated by extraction with aluminium chloride and resolved with mercuric chloride. J. W. H.

204.* Molecular Volume Nomograph for Liquid Alkanes. D. S. Davis. *Industr. Engng Chem.*, 1942, **34**, 797.—A nomograph is given which enables the reduced temperature and molecular volume to be read off directly over the temperature range −170° to +70° C. for the alkanes from ethane to octane with an accuracy of 0·4%. J. W. H.

205.* Hydrocarbon–Water Solubilities at Elevated Temperatures and Pressures. J. Griswold and J. E. Kasch. *Industr. Engng Chem.*, 1942, **34** (7), 804.—The solubility of water in three petroleum fractions has been determined up to 280° C. and 940 lb. sq. in. At this temperature and pressure the water solubility has a value of 45 mol%. The solubility is independent of the molecular weight for straight-run fractions, but aromatic hydrocarbons show a higher solubility. Similar data from the literature is given for the solubility of hydrocarbons in water, and this solubility is shown to be a function of molecular weight and hydrocarbon type. J. W. H.

206.* Pressure Drop in the Flow of Compressible Fluids. W. E. Lobo, L. Friend, and G. T. Skaperdas. *Industr. Engng Chem.*, 1942, **34** (7), 821.—Considerable error can arise in the calculation of the pressure drop for compressible fluids if the kinetic energy term of the Bernoulli equation is neglected. A chart is presented which enables the pressure drop to be corrected for kinetic energy change. An example is given in which it is shown that the pressure drop may be in error to as much as 25% if the kinetic energy term is neglected. J. W. H.

207.* Rapid Solution of Multicomponent Distillation Problems. G. Karnofsky. *Industr. Engng Chem.*, 1942, **34** (7), 839.—The method proposed by Hibsham (*ibid.*, **32**, 988) for estimating the number of theoretical plates required for a given separation has been modified so as to dispense with the construction of a transparent Cox's vapour-pressure chart. This chart is replaced by a vapour-pressure nomogram which is used in conjunction with the operating line data to determine the plate-to-plate composition by a simple graphical construction. J. W. H.

208.* Critical States of Two-Component Paraffin Systems. F. D. Mayfield. *Industr. Engng Chem.*, 1942, **34** (6), 843.—Empirical correlations are given between the composition and the critical temperature and the critical pressure for two-component paraffin systems, and it is shown that the results can be calculated to within 13 lb. sq. in. and 6·4° F. for eight of the systems for which published data are available. The

critical temperature is directly proportional to the weight per cent. composition. The critical pressure does not follow any such simple rule, but a chart is given which enables the deviation from an additive rule to be estimated form the calculated value of the critical temperature. J. W. H.

209.* Specific Dispersion of Pure Hydrocarbons. R. E. Thorpe and R. G. Larsen. *Industr. Engng Chem.*, 1942, **34** (7), 853.—The specific dispersions are given for some 250 different hydrocarbons comprising conjugated and non-conjugated olefins, alkyl aromatic, complex benzene hydrocarbons and aromatic-naphthenic complexes. From an analysis of these data it is shown that it is possible to calculate the specific dispersion from the molecular structure to an accuracy of five units in 75% of the examples given. J. W. H.

210.* Graphical Methods for Interconversion of Ternary Compositions. K. H. Sun and A. Silverman. *Industr. Engng Chem.*, 1942, **34** (7), 872.—Graphical methods are given for the interconversion of mol. weight, and volume fractions for ternary mixtures, which enable the conversion to be made rapidly when these become routine operations. J. W. H.

211. Joule–Thomson Coefficients in the Methane–Propane System. R. A. Budenholzer, D. F. Botkin, B. H. Sage, and W. N. Lacey. *Industr. Engng Chem.*, 1942, **34** (7), 878.—Determinations of the Joule–Thomson coefficients have been made at pressures up to 1500 lb. sq. in. and over the temperature range 70–310° F. for three mixtures of methane and propane. From these experimental data the isothermal enthalpy-pressure coefficients have been calculated and the partial enthalpy of the individual hydrocarbons in the mixture has been established. J. W. H.

212. P-V-T-x Relations of the System Propane–Isopentane. W. E. Vaughn and F. C. Collins. *Industr. Engng Chem.*, 1942, **34** (7), 885.—Experimental data are given for the P-V-T-x relations of five mixtures of propane and *iso*pentane over the temperature range 0—300° C. and in the pressure range 2–80 atmospheres. These data include the two-phase and critical regions. From these data the liquid vapour equilibrium constants have been calculated, and their relationship with pressure is shown graphically. J. W. H.

213. *Mixed Solvent Extraction. T. G. Hunter. *Industr. Engng Chem.*, 1942, **34** (8), 963.—The minimum number of experiments required to establish the phase equilibrium relationship for a ternary system is shown to be three, and ten for a quaternary system containing one pair of partly miscible components. The tetrahedron method of plotting the results of a quaternary system are discussed, and it is shown that the orthogonal projection of the tetrahedron is the most convenient manner of illustrating the results. The geometrical construction of this orthogonal projection is given, and an actual example worked out and shown in detail. J. W. H.

214.* Viscosity of Propane, Butane, and *iso*Butane. M. R. Lipkin, J. A. Davison, and S. S. Kurtz. *Industr. Engng Chem.*, 1942, **34** (8), 976.—The viscosities of propane, *n*-butane, and *iso*butane have been determined over the temperature range −75° to +40° C. These data extend considerably the range over which viscosity data are known. Within the ranges of previous determinations excellent agreement is shown with the results of other workers. A linear plot is obtained for the normal paraffins when the viscosity at 25° C. is plotted against the number of carbon atoms. J. W. H.

215.* Methane–Isobutane System. R. H. Olds, B. H. Sage, and W. N. Lacey. *Industr. Engng Chem.*, 1942, **34** (8), 1008.—The phase behaviour of the system methane–*iso*butane has been examined over the temperature range 100–460° F. and up to a pressure of 5000 lb./sq. in. Experimental determinations of the specific volume and dew-point have been made and the compressibility and equilibrium constants calculated. J. W. H.

216. Concentration Change. G. H. Horne. *Industr. Engng Chem.*, 1942, **34** (9), 1042.—A graphical solution relationship is given showing the number of times a system must be flushed to ensure any desired purity of exit product. Perfect mixing is assumed, and any tendency to deviate from this assumption in actual practice will result in a smaller number of flushes being required. J. W. H.

217.* Correlating Vapor Pressure and Latent Heat Data. D. F. Othmer. *Industr. Engng Chem.*, 1942, **34** (9), 1072.—It is shown that $\log P_R/\log P'_R = L_R/L'_R$, in which P_R is the reduced pressure and L_R the reduced latent heat (latent heat/critical temperature). By the use of this equation the latent heat of any substance may be estimated by comparison with some standard substance such as water. This relationship has the greatest accuracy in the critical region. Nomograms are given which enable the reduced temperature and pressure to be estimated, and the ratio of the values to those of water to be determined readily. J. W. H.

218.* Binary Mixtures for Testing Fractionating Columns at Atmospheric and Reduced Pressures. L. B. Bragg and A. R. Richards. *Industr. Engng Chem.*, 1942, **34** (9), 1088.—From the determination of the efficiency of Stedman packing under vacuum conditions, the relative volatility and composition of the binary mixture benzene–ethylene dichloride have been determined at 100, 200, 400, and 760 mm. pressure.

The data demonstrate that this mixture is not ideal, and that at 760 mm., on comparison with other workers, a considerable divergence of results is shown.

Data are also given for the relative volatility and composition for the binary mixture *o*-dichlorobenzene and diethylbenzene at pressures of 10 and 50 mm. J. W. H.

219.* Phase Equilibria in the System Methane–*n*-Pentane. B. H. Sage, H. H. Reamer, R. H. Olds, and W. N. Lacey. *Industr. Engng Chem.*, 1942, **34** (9), 1108.—The specific volume of six mixtures of methane and *n*-pentane have been determined over the temperature range 110–460° F. and at pressures up to 5000 p.s.i. At a number of temperatures the bubble-point and dew-point pressures have been determined and the composition of the dew-point gas established. From these data the enthalpy and fugacity pressure and temperature relationships have been calculated. J. W. H.

220.* Simplified Calculation of Theoretical Plates. G. W. Thomson and H. A. Beatty. *Industr. Engng Chem.*, 1942, **34** (9), 1124.—Based on the assumptions that the operating lines and equilibrium curve are linear near the ends of an x–y diagram, equations are derived for the calculation of the number of theoretical plates required for the separation of a binary mixture containing less than 5 mol.% of one component. The results calculated by this method do not differ appreciably from the values calculated from the more complex Smoker equation. The use of the method is illustrated by examples. J. W. H.

221.* Heat Balance Equations for Multiple-Effect Evaporators. M. G. Larian. *Chem. Met. Eng.*, October 1942, **49** (10), 90–91.—In multiple-effect evaporator design calculations, the most important quantity to be calculated is the heat-transfer area. The heat-transfer area is calculated by the simultaneous solution of three equations: (1) The heat-balance equation, (2) the heat-transfer rate equation, and (3) the capacity equation. The heat-balance equation to be used depends on the method of feeding the evaporator, and on the temperature of the dilute feed. There are four different methods of feeding, and the dilute feed may enter the evaporator at a temperature which may or may not require preheating in the effect which it enters. In the latter case the feed may or may not flash. There are therefore several combinations of conditions possible. These are discussed.

Evaporators may be fed in the direction of decreasing pressure drop, with the new feed entering the first effect and passing thence to the second, third, and later effects, if any. This is known as forward feeding. Or the feed may first enter the last effect, in which the pressure is lowest, and flow forward through each earlier effect to the first, which is known as backward feeding. Mixed feeding is the procedure where the new feed enters some other effect than the first or last. There are various methods of mixed feed, depending on the requirements, a common method in the case of a

quadruple-effect evaporator being to introduce the new feed in the second effect, from which it flows in turn to the third, fourth, and finally to the first.

The equations for all four methods are given and two cases are discussed in detail.
A. H. N.

222.* **Recent Advances of Catalysis in Chemical Process Industries.** N. W. Krase. *Chem. Met. Eng*, October 1942, **49** (10), 104.—A large portion of this paper is cut out by the censor, and thus no adequate abstract is possible. The remaining portions deal with fluid catalysts, catalysts in hydroforming, the production of toluol and aviation fuels by catalytic processes, and a little on catalytic isomerization. The treatment is a brief review of plants, giving, where possible, pertinent data and general figures on capacity. A. H. N.

223. **Patent on Chemistry and Physics of Hydrocarbons.** C. F. Bonnet. U.S.P. 2,301,609, 10.11.42. Appl. 30.1.41. Petroleum emulsions of the water-in-oil type are broken by subjecting them to the action of a demulsifying agent containing an acidic nitro-aromatic compound selected from the group consisting of nitrophenols and acidic nitro-aromatic carboxylic acids. H. B. M.

Motor Fuels.

224. **The Use of Substitute Motor Fuels on the Continent.** W. Landsberg. *Engineering*, 1942, **153** (3969), 114–115.—The substitute fuels available may be classified under the following groups: producer gas, highly compressed gases, and liquefied gases.

Despite the technical deficiencies of the producer-gas system, the ample availability and variety of relatively cheap fuels have resulted in its becoming the most popular substitute. In Germany in particular efforts in this direction have been most strenuous, some 150,000 units being in service in 1941, with a large expansion programme in view. In Italy, methane has been used extensively, but it appears that natural-gas supplies are already falling short of requirements.

One of the biggest problems of the producer-gas system is the protection of the generator and engine from corrosion. Standardization of plant has been impossible on account of the varying qualities of fuel available in the countries under Nazi control.

In spite of the efforts made, the author considers that the saving in liquid fuel is only of the order of 5–10% of the civilian demand of Hitler's Europe. J. G. W.

225. **Patents on Motor Fuels.** E. A. Ocon. U.S.P. 2,300,691, 3.11.42. Appl. 17.4.39. In the production of a high anti-knock motor fuel a crude petroleum is fractionated and distilled to form a naphtha distillate fraction, a higher-boiling cracking stock distillate, and a residue. The residue is partly vaporized, and the vapours are passed through an adsorbent contact mass and partly condensed. The condensate obtained in this manner is mixed with the distillates of the crude petroleum, and the cracking stock distillate is cracked. The naphtha distillate is reformed and parly oxidized to produce oxygen-containing aliphatic compounds boiling within the gasoline range. The partly oxidized reformed naphtha is cooled and then reacted with a reducing gas containing principally hydrogen and carbon in the presence of a basic dehydrating metal oxide catalyst. The gasoline boiling-range products are finally combined with gasoline products from the cracking process.

J. L. Huggett. U.S.P. 2,301,281, 10.11.42. Appl. 16.1.40. Production of high-quality motor fuels of increased stability from petroleum oil fractions boiling below 420° F. The petroleum oil fractions have a relatively low sulphur content, and are of such a character that they would not be subjected to treatment with sulphuric acid for the reduction of sulphur. Initially the petroleum oil is separated into a relatively high-boiling fraction and a relatively low-boiling fraction. The former fraction is treated with sodium carbonate solution, and the latter is treated with a stronger solution of sodium hydroxide. The oils are separated from the respective treating agents and blended to produce high-quality motor fuel.

F. E. Frey. U.S.P. 2,301,391, 10.11.42. Appl. 24.3.36. Method of converting a normally gaseous hydrocarbon mixture containing both saturated and unsaturated

hydrocarbons into normally liquid hydrocarbons of the gasoline boiling range. The original mixture is subjected in a first zone to conditions of pressure and temperature adequate to convert a substantial portion of the unsaturated hydrocarbons to normally liquid products. From the effluent from this zone are separated a fraction boiling within the gasoline range and a fraction boiling above this range. These two fractions are subjected in a second zone to a higher temperature than that obtaining in the first zone. Conditions are so adjusted that a substantial portion of aromatic products boiling within the gasoline range is produced. Finally the normally liquid hydrocarbons are separated from the effluent from the second zone.

F. C. Koch. U.S.P. 2,301,548, 10.11.42. Appl. 5.2.40. A process of conversion of hydrocarbons into motor fuels which involves absorbing gases, predominantly ethane, in the oil to be cracked to produce a mixture which can be separated into the following four fractions: (1) a mixture of hydrogen and hydrocarbons having 1–4 carbon atoms per molecule; (2) hydrocarbons within the gasoline boiling range; (3) a recycle stock within the gas-oil boiling range, and (4) tar. Fraction (3) is returned to the cracking zone; (2) is withdrawn; (1) is cooled and compressed to liquefy some of the C_3 and C_4 hydrocarbons. The C_3 and C_4 hydrocarbons are heated to convert them to olefins, and these are introduced into the converted oil. A C_2–C_3 fraction is at least partly separated from (1) by absorption in gas-oil. A gas, predominantly hydrogen and methane, is bled from the process, and finally the C_2–C_3 gas-enriched gas-oil is passed to the cracking zone.

R. M. Melaven and R. V. Shankland. U.S.P. 2,301,734, 10.11.42. Appl. 30.12.38. Heavy hydrocarbon oils are converted into gasoline by subjecting them at a temperature between 700° and 1050° F. to the action of a catalyst consisting essentially of a silica gel treated with a cerium compound in an acid solution. H. B. M.

Gas, Diesel, and Fuel Oils.

226. Rotary Oil Burners for Low Pressure Steam Boilers. W. E. Bruce. *Industr. Pwr and Fuel Econ.*, May 1942, 40–41.—It is reported that rotary burners were first employed in the Western States of America. Initially it was deemed possible to operate these only with a light grade oil of low flash point and viscosity which did not require preheating. Subsequently it was found that the high latent heat of low-pressure steam enabled oil temperatures of 100° F. to be maintained in ordinary heaters, and that in these circumstances good atomization and combustion were achieved with the heaviest grade of oil. In other words, the rotary burner could burn the same class of fuel as the standard type, though it suffered from serious disadvantages where high pressures were concerned.

Every rotary burner required an electric motor, the failure of which put it out of action until a spare could be installed. They had to be made in different sizes for varying capacities and with one-, two-, and three-phase and D.C. motors to suit electric current supply. This made the system expensive.

Advantages of the rotary burner were that extensive variation of fire at each individual burner was possible with no tip to change or clean; better air distribution; and simpler operation.

In the early days of the burner, oil was not graded as it is now. Heavy fuel oil was usually specified at 15 Beaumé, but in actual fact it was frequently 12, 10, or even 8. Difficulties of burning the heavy type of Bunker fuel oil remained great, and operation of the rotary burner with the lighter types of oil, which did not require preheating, proved most satisfactory. To-day, however, it is claimed that the rotary burner remains a simple, efficient medium for burning any kind of oil without the elaborate installation and skilled attention necessary with the high-pressure type. H. B. M.

227. Engine Efficiency Research Equipment. *Industr. Pwr* and *Production*, July 1942, 72–75.—The Research Department of the National Gas and Oil Engine Co., Ltd., reports that the war has greatly curtailed the work of the Department. It is maintained, however, that vast quantities of fuel oil can be saved each year as a direct result of carefully organized research.

For powers over 20 h.p. the company employs for testing purposes Heenan and

Fronde hydraulic dynamo-meters, in which the output is measured by the torque reaction of a swirling mass of water set in motion by an impeller driven by the engine.

Special measuring devices are employed to test fuel-oil consumption of all experimental engines. By means of these the engineer can obtain results with a tolerance of only 0·26%, or about 0·001 lb. per b.h.p. hour. For larger engines a refined direct weighing method is employed.

Measurement of exhaust temperature is made by an "Elliott" multi-point pyrometer, great care being taken to see that the sheaths of thermo-couples project the same depth into the exhaust pipe of all engines. Only in this way can true comparisons be made.

Other apparatus employed by the company includes a "Sigma" calorific value indicator for measuring the gross value of gas corrected for atmospheric pressure and temperature; a Kent orifice and curved tube manometer by means of which rates of flow from 30 to 30,000 cu. ft. per hour can be measured; a Junkers gas calorimeter for checking the "Sigma" indicator and two gas analysis apparatus, one of which can be used for the analysis of coal or Mond gas. For engine indicating either the cathode-ray oscillograph with camera attachment or the Farnborough electric indicator is used.

H. B. M.

228.* **Performance Characteristics and Specifications of Diesel Fuel Oils.** W. L. Nelson. *Oil Gas J.*, 17.9.42, **41** (19), 47.—Fuels for use in diesel engines powering trucks, tractors, and tanks are becoming of increasing importance. Specifications for such fuels are becoming standardized, and tables presented show: (1) typical specifications and average properties of some diesal fuels, (2) cetane number, diesel index, pour point, boiling range, and viscosity of typical straight run diesel fuels from crude stocks of various types, and similar properties of typical light and heavy cracked oils. High-ignition-quality oils are generally of higher boiling range than the low-ignition-quality oils, due to normal production of kerosine from such crudes, and the pour points are also considerably higher. Difficulty in the production of diesel fuels of satisfactory ignition quality arises mainly because of the difficulty of obtaining a low pour point. This may be accomplished (*a*) by blending high-ignition-quality, high-pour-point oils with cracked, low-pour-point oils; but tends to production of poorer ignition quality and somewhat unstable oils, (*b*) producing a low-boiling-range straight-run stock, which interferes with kerosine manufacture, (*c*) use of wax crystallization inhibitors or dewaxing the oil, which methods are too costly relative to the usual value of the distillates.

Likewise solvent extraction of low-ignition-quality oils is usually uneconomic. In other words, the claim of the diesel-engine manufacturers of low fuel cost is not a fact if large quantities of high-quality fuel are demanded.

Fuel tests applied and specified can, generally speaking, be grouped under five performance-characteristic headings.

(1) Ignition quality, at present usually evaluated by determination of diesel index and cetane number, or indirectly by the octane blending number. The harmful effects on engines due to the use of fuels of inferior ignition quality are described. The range of suitable cetane numbers indicated are: for diesel electric motors 52, high-speed engines 47, medium-speed engines 43, low-speed engines 38, and corresponding diesel indexes are 50, 46, 44, and 40.

(2) Cleanliness is determined by sediment and water, ash content, and modified gum content tests. General complaints which involve cleanliness are probably more prevalent than any other criticism, but the presence of adventitious matter must arise primarily during handling and storage. Freedom from abrasive matter and water is of the greatest importance in view of the nature of the fuel-injection pumps and fabric filters employed on engines. Suitable specification limits are suggested for various types of fuel.

(3) Flow and atomization. Viscosity and pour point are related to these performance characteristics. Viscosity at the injection nozzle must be controlled within close limits, particularly the viscosity must not be too low, or decrease in power output may result. Viscosities of fuels used in 1939 for various types of engines are listed.

(4) Volatility may be evaluated by A.S.T.M. distillation curve, Conradson carbon value, particularly when applied to 10% fuel bottoms, and indirectly by gravity.

Relationships between these properties and production of smoke, engine deposits, etc., are discussed.

(5) Corrosion. Control tests employed are sulphur content, free acidity, and copper-strip test. Literature references on performance characteristics of diesel fuels are appended. R. A. E.

Lubricants and Lubrication.

229. Oil Purifying Auxiliary Equipment. Shop Transport of Supplies. *Industr. Pwr and Fuel Econ.*, February 1942, **23**.—A portable compartment tank, divided equally for holding clean and dirty oils, and with a capacity of 75 gals., is described and illustrated. The essential function of this unit is to carry dirty oils from various points in industrial works to a central oil-reclaiming plant. All types of used oils can be transferred into the dirty-oil compartment by means of a semi-rotary hand-pump fixed to the top of the tank. The oil can then be replaced from the clean-oil compartment. Flexible hoses are supplied with the equipment to facilitate operation. The actual model illustrated is 3 ft. long, 2 ft. wide, and 2 ft. deep, but larger or smaller units could be constructed to meet specific works requirements. H. B. M.

230. Inspection of Bearing Surfaces. W. N. Twelvetrees. *Aircraft Eng.*, 1942, **14** (160), 173.—The paper is subdivided into the following sections: (1) White Metal, Phosphor Bronze, and Iron; (2) Steel; (3) Lead Bronze; (4) Lead; (5) Later Developments with White Metal and Bronzes. In each section the properties and peculiarities of the bearings are discussed, together with the requirements for satisfactory operation. J. G. W.

231. Graphical Solution of Fluid Friction Problems. E. S. Dennison. *Engineering*, 1942, **153** (3972), 179–180.—A graphical method is described for the solution of fluid friction problems in which a knowledge of Reynold's number is required and which would normally be solved by trial-and-error methods.

The principle is applied to the determination of terminal velocities of falling bodies, the diameters of pipe-lines, and flow velocities. J. G. W.

232. Wear Inhibiting Agents in Lubricating Oils. Anon. *Engineering*, 1942, **154** (3999), 195.—A summary is given of the paper "Some Aspects of Industrial Lubrication," by W. J. Hund, R. G. Larsen, O. Beeck, and H. G. Vesper.

A characteristic of boundary lubrication is that the coefficient of friction is practically independent of viscosity and sliding velocity.

The effect of chemical polishing agents on wear is discussed. Reduction of boundary friction did not necessarily result in reduction of wear. The best-known example was tricresyl phosphate, which apparently acted in a corrosive, rather than a protective, manner.

In addition to polishing the surface, an anti-welding film must be formed, and the surface should contain minute oil crevices between areas of unbroken level. J. G. W.

233.* Viscosity Pole and Pole Height of Ubbelohde. S. S. Kurtz. *Industr. Engng Chem.*, 1942, **34** (6), 770.—A short note is given on the method of calculating the viscosity pole and pole height. These properties correspond to viscosity index and viscosity gravity constant, but there is no correlation between the two factors. J. W. H.

234.* Oxidation Characteristics of Lubricating Oils. G. H. von Fuchs and H. Diamond. *Industr. Engng Chem.*, 1942, **34** (8), 927.—An apparatus is described for automatically measuring the oxygen absorption of lubricating oil. In this apparatus the oxygen is continuously pumped through the heated oil, the volatile oxidation products removed, and the decrease in volume of the oxygen measured. In addition to the measurement of oxygen absorption, it is shown that the saponification number is of importance in determining the types of oxidation products formed. It is shown that saturated hydrocarbons exhibit autocatalytic oxidation effects and aromatic hydrocarbons act as anti-oxidants by a mechanism of auto-retardation. The balance between these

two opposing effects is governed by the reaction temperature. It is shown that, under specified conditions, an increase in the aromaticity increased the stability until a maximum stability is reached, and that at a certain value of the aromaticity any further increase results in a decrease in the stability. J. W. H.

235. Movement, De-oiling, and Disposal of Swarf. Anon. *Industr. Pwr and Production.* October 1942, 112–113.—In this article is described a plant capable of recovering up to 30 gals. of cleaned oil per ton of swarf handled, with an estimated saving of nineteen man-shifts per day. It has already been in use for two years at a B.S.A. Group works, and reports on its performance are favourable.

Throughout the process of de-oiling the swarf is moved on a conveyor of the plate-belt type, the top portion of which passes along the bottom of a tank with a curved base, giving the swarf its first washing. The swarf which emerges on the conveyor belt is passed beneath several hot-water sprayers for its second cleansing. The water washings, mixed with oil from the swarf, drain into a collecting tank, which is divided into two sections to avoid eddy currents. A temperature of 180° F. is maintained in the tank. The oil forms a surface layer on the tank, which is fitted with a floating pipe through which the oil is withdrawn. The " dirty oil " is pumped to an overhead tank, also maintained at a temperature of 180° F., whence it is fed to a centrifuge, and afterwards to another tank. It is then ready for re-use in the shops. The quality of the reclaimed oil is reported to be excellent, averaging only about 0·2% of water, containing no harmful bacteria, and being acid-free. H. B. M.

236.* Evaluating Petroleum Lubricants. J. W. Poole. *Petrol. Engr,* 1942, **13** (10), 175.—The two most important obstacles facing the chemist in the field of lubrication are considered to be the highly complex nature of petroleum lubricants and the extreme variability of the conditions under which they perform. Lubricating oils have been divided into semi-arbitrary chemical groupings, paraffinic, olefinic, naphthenic, aromatic, and resinous, which, although inclusive of all oil constituents, are not rigidly distinctive. Moreover the terms " naphthenic " and " aromatic " have been confused, each having been used to signify that the nature of the material is antithetical to " paraffinic." In this article " paraffinic " and " naphthenic " (" aromatic ") oils respectively refer to oils with a viscosity index of 90 or over and 20 or under.

In general, paraffinic oils appear to be stable in service and resistant to chemical action, but they do form " lacquer," which eventually leads to serious engine deposits of hard and tenacious character, causing piston-crown scuffing with aluminium pistons. General Motors Research Labs. have discovered that the stability of paraffinic oils is more apparent than real, since they produce resinous material, which remains dissolved in the parent medium, but is precipitated as a gummy mass when fresh paraffinic oil is added, and causes sticking of vital engine parts. On the other hand, the high V.–I. oil helps easy starting in cold weather, is less prone to cold driving " moisture sludge," and seems to be the best compromise for winter crankcase problems.

Non-paraffinic low V.-I. oils are, in general, sludge formers; at low temperature they form " moisture sludge " and at high temperature " high-temperature sludge." They cause difficult starting in cold weather. They are, however, as good lubricants as paraffinic oils, and their deposits are not so likely to include " lacquer." They give soft " carbon," are less likely to cause scuffing, and are rarely corrosive to high-duty alloy bearings.

Intermediate oils, between the two extremes, are not necessarily intermediate in properties, and are just as likely to have the deficiencies of both types as the desirable attributes.

The reactions of crankcase chemistry are so multivariant (variations include temperature, time, chemical nature of materials of construction and of chance invaders of the system, mechanical type and condition of the equipment, etc.), and so complexly interdependent as to be practically unpredictable at present. For example, oxidation may lead to auto-accelerators or to auto-retardants of the oxidation reaction, and these products may be useful or detrimental from other aspects. In general, conventional criteria consisting of rapidly determinable laboratory characteristics are not reliable guides to lubricating-oil performance. Tests in engines under actual conditions, or controlled conditions simulating service, are time-consuming and expensive, but are by far the best standards of quality at present available. J. C.

237. Patents on Lubricants and Lubrication. M. S. Agruss, H. Schindler, and G. W. Ayers. U.S.P. 2,300,391, 3.11.42. Appl. 21.6.40. A small proportion of a petroleum resin-halogenated hydrocarbon condensation product is added to a lubricating oil normally deficient in green fluorescence to produce the desired flourescence.

W. A. Proell. U.S.P. 2,301,795, 10.11.42. Appl. 16.6.41. The formation of sediment in a liquid-mineral-oil composition is greatly reduced by the addition of a small amount of an oil-soluble metal soap and a small amount of an aromatic hydroxy-aldehyde. H. B. M.

Asphalt and Bitumen.

238.* Oxidation of Asphalt in Thin Films. A. R. Ebberts. *Industr. Engng Chem.*, 1942, **34** (9), 1048.—The oxygen absorption of a thin film of asphalt is measured by means of potassium permanganate. The results of a number of tests on asphalts from different sources are given. It is concluded that if good service is to be obtained from a pavement asphalt the oxygen absorption must be low. J. W. H.

Special Products.

239.* Make Butadiene by Catalytic Dehydrogenation of Butane. W. T. Ziegenhain. *Oil Gas J.*, 20.8.42, **41** (15), 30.—A description with flow-sheet is given of a plant designed to produce 15,000 tons per annum of butadiene by the Houdry process. The plant consists essentially of six reactors, heaters for the first and second stage reactions, a vapour-recovery system, and a butadiene purification system. Each reactor works on a 90-min. cycle, during which it operates for one 15-min. period on first-stage reaction, and two periods of 15 min. each on the second-stage reaction. Thus one reactor is always on stage one, two are on stage two, whilst in the remaining three purging or revivifying of catalyst is taking place. In stage one butane is heated to 1050° F. and passed to one of the reactors, where it is partly dehydrogenated under a pressure of 5–10 mm. Hg absolute. The evolved gases pass to the vapour-recovery system, where the butane/butene portion is concentrated, and after butadiene removal, pass to the second stage heater, where the mixed gases are heated to 1100° F. for delivery to the second-stage reactors. The products of the second-stage dehydrogenation are mixed with those from the first and compressed to 115 lb. per sq. in. before entering the vapour-recovery system. Gas analyses and material balances are tabulated and a 17% concentration of butadiene in the effluent from the second stage is expected. The reactors are 12 ft. in diameter and 12 ft. long, 1 in. thick and fire-brick lined, thus permitting use of carbon steel for the shell. Each reactor contains a 3-ft. bed of catalyst, the estimated life of which is six months.

The butane/butene fraction from the vapour-recovery system passes to the butadiene extraction and purification system; in the extractor the ascending vapours meet a descending flow of solvent which extracts the butadiene. The spent butane fractions pass from the top of the extractor to a scrubber for removal of entrained solvent by means of a water-wash. The overhead product is condensed and delivered to the second-stage heater, whilst the solvent is recovered from the water solution in a stripper. The purity of the butadiene in solvent is improved to the desired standard by recycling butadiene vapour from the desorber, which gives the desired butene stripping effect. Rich solvent from the extractor passes to the desorber, where butadiene is vaporized, and the lean solvent is subsequently cooled and passed back to the extractor. Butadiene from the desorber enters a washer for removal of solvent by water and is then condensed, inhibited and sent to storage under a pressure of 70/75 lbs. per sq. in.

Estimates are given of utility requirements of the plant and of the costs of operation. With butane available at 6 c. per gal. butadiene is expected to cost 6·77 c. per lb. R. A. E.

240.* Chlorination of Methane. E. T. McBee, H. B. Hass, C. M. Neher, and H. Strickland. *Industr. Engng Chem.*, 1942, **34**, 296.—The process described enables the direct chlorination of methane to be controlled to produce the four chloromethanes, the individual ratio of which in the products can be controlled from nearly 100% CH_3Cl

to CCl_4. This reaction is carried out by the controlled addition of chlorine to methane at a number of points in a continuous reactor. Data are given on the design and spacing of the chlorine jets, the effect of the number of jets and the effect of mol. ratio and temperature. J. W. H.

241.* **Effect of Low Temperatures on Neoprene Vulcanizates.** F. L. Yerzley and D. F. Fraser. *Industr. Engng Chem.*, 1942, **34**, 332.—Several tests are described for investigating the ability of synthetic rubbers to resist low temperatures. Data are given on the resistance to freezing of several synthetic rubbers, including data on the effect of various softeners. J. W. H.

242.* **Nitromethane-*iso*Propyl Alcohol–Water System.** J. E. Schumacher and H. Hunt. *Industr. Engng Chem.*, 1942, **34** (6), 701.—The vapour-liquid equilibria for the binary and ternary systems of nitromethane, *iso*propyl alcohol, and water are given. The binary and ternary systems form minimum boiling azeotropes. Data on the mutual solubility of nitromethane and water are given, and a method for the separation of nitromethane from the ternary system is discussed. J. W. H.

243.* **Solvent Properties of the Isomeric Paraffins.** E. H. McArdle and A. E. Robertson. *Industr. Engng Chem.*, 1942, **34** (8), 1005.—Data are given for the solvent properties of the two isomeric pentanes, four isomeric hexanes, *n*-heptane, and triptane with respect to low-molecular-weight polybutenes and alkyd resins. Although the solvent power of these paraffins is shown to be similar, the viscosity of the solutions are greatest for the highly branched paraffins, even when these viscosities are adjusted to a reduced temperature basis. J. W. H.

244.* **Nitroparaffins as Solvents in the Coating Industry.** C. Bogin and H. L. Wampner. *Industr. Engng Chem.*, 1942, **34** (9), 1091.—The solvent power and applications of the nitroparaffins are discussed, with particular reference to their use in the coating industry. J. W. H.

245. **Patents on Special Products.** R. A. Gerlicher. U.S.P. 2,301,270, 10.11.42. Appl. 9.11.40. High-quality phenols are produced from crude phenol fractions segregated from mineral oils by distilling the original material in the presence of added high-molecular-weight petroleum asphalt under conditions designed to remove overhead the refined phenols and to remove as a fluid-bottom products the added hydrocarbon and impurities present in the feed phenol fraction.

J. C. Showalter and M. Wiggen. U.S.P. 2,301,335, 10.11.42. App. 1.9.39. Process of preparing derivatives of petroleum hydrocarbon acid sludge. The sulphuric acid sludge, obtained by treating cracked hydrocarbon naphthas with sulphuric acid, is treated with water, and an acid-water solution is separated from the sludge. The residual material is treated with water, and an acid-water solution is separated from the sludge. The residual material is treated with propane and allowed to settle. A layer of the carbonaceous material which settles out is removed and the residual material is distilled to remove propane. The residual material is treated with sulphuric acid which is afterwards removed. After clay treatment the residual material is separated into an oil fraction and a fraction which is solid at ordinary temperatures.

L. A. Hamilton, R. C. Moran, and A. R. Cattell. U.S.P. 2,301,806, 10.11.42. Appl. 9.3.40. A white refined paraffin wax product is inhibited against the formation of deleterious colour upon prolonged exposure to light by the addition of a small amount of an ester of an alkyl monohydric alcohol and an oxygen containing acid selected from the group consisting of aliphatic hydroxy-acids, phthalic acid, and oxygen acids of phosphorus. H. B. M.

Detonation and Engines

246.* **Prediction of Octane Numbers and Lead Susceptibilities of Gasoline Blends.** D. Eastman. *Industr. Engng Chem.*, 1941, **33** (12), 1555.—A method of predicting the octane numbers of blended gasolines is given which is based on a knowledge of the Motor Method and Research Method ratings of the components. A blending co-

efficient is determined from the difference in octane sensitivities of the stocks blended, from which the Motor Method octane number of the mixture can be predicted.

A modification of the Hebl, Rendel, and Garton chart is presented for the evaluation of lead response, and correlations for the prediction of this factor from sulphur content and octane sensitivity are given. Methods for the prediction of the lead response of blends are described. J. G. W.

247. Thermal Air-Jet Propulsion. Gohlke. *Aircraft Engineering*, 1942, **14** (156), 32.—A comprehensive summary is given of the patents dealing with air-jet propulsion. These have in common : the air compressor, the combustion chamber, and the expansion tunnel (diffuser). The essential difference between them lies in the method of compression. J. G. W.

248.* Combustion in Diesel Engines—Effect of Adding Gaseous Combustibles to the Intake Air. M. A. Elliot and L. B. Berger. *Industr. Engng Chem.*, Industrial Edition, 1942, **34** (9), 1065.—Experiments on the effect of adding natural gas to the air intake of two commercial diesel engines are described. These studies were initiated as part of a programme to evaluate the hazards that might attend the use of diesel engines in mines or other underground operations, but information was gained incidentally on combustion phenomena in this type of engine.

The composition of the exhaust products indicated an effect analagous to the lower limit of inflammability. The existence of overlean regions in which the flame does not propagate is discussed, and evidence is offered indicating that such regions are the source of carbon monoxide and aldehydes in the exhaust gas at mixtures less than chemically correct. J. G. W.

249.* Equations for the Specific Heats of Gases. J. C. Smallwood. *Industr. Engng Chem.*, 1942, **34** (7), 863.—Condensed equations and constants are given for calculating the specific heats of O_2, N_2, CO, H_2O, CO_2, and air, for combustion purposes. J. W. H.

Coal and Shale.

250. Fused Spent Shale from a Retort at Pumpherston, Midlothian [Scotland]. J. Phemister. *Trans. Geol. Soc., Glasgow*, September 1942, **20** (2), 238–247.—Fragments of fused spent shale in slag are surrounded by two shells, the inner almost opaque retaining some of the structure of the shale, and the outer finely recrystallized as cordierite ($2MgO{\cdot}2Al_2O_3{\cdot}5SiO_2$) in a glassy or opaque grey matrix. In the slag one finds ferromagnesian silicates and spinel in an irregularly fluxional aggregrate of cryptocrystalline and microcrystalline material. Cordierite forms prisms up to 0·1 mm. in length. Bytownite-anorthite gives microlites, laths, and prisms up to 0·5 mm. Olivine—ferrohortonolite—appears as spongy grains reaching 1 mm. across. Pyroxene occurs as grains and prisms, and, if non-aluminous, is identified as a diopside-hedenbergite.

Cordierite may be produced (1) in the unfused shale, as in contact altered argillaceous rocks, (2) in the corona around the fragments, (3) in practically holocrystalline parts of the slag, (4) in glass as idiomorphic crystals. It may either grow in heated solid rock or be precipitated from fusion.

The high concentration of cordierite in certain positions is attributed to selective diffusion of the fluxing oxides CaO and FeO to places where fusion is initiated, leaving the MgO and Al_2O_3 behind to crystallize as a sinter of cordierite crystals.

The temperature at the bottom of retorts is, according to E. B. Bailey (1927), only 705°, while temperatures of fusion of the system $MgO–Al_2O_3–SiO_2$, which quench to cordierite and glass, are given by Rankin and Mervin (1918) as from about 1350° to 1450° C.

Phemister quotes comparisons of the fused shale with naturally occuring buchites, or basalt-jasper, and refers to the aluminous xenoliths in the tholeites of Mull, the vitrified phyllites of Argyll, and the Tertiary sediments of south-west Persia, which have been metamorphosed by combustion of hydrocarbons.

The fused shale, mixed with about 10% of lime, is used for brick-making. A. L.

Economics and Statistics.

251. **Petroleum Research and Wars.** B. T. Brooks. *Industr. Engng Chem.*, 1942, **34** (7), 798.—A general review is given of the part which research has played in the development of the oil industry with particular reference to processes of value in time of war. The future of research in oil industry progress is also considered. J. W. H.

252. **Axis Draws on many Sources for Petroleum Supplies.** G. Egloff and P. M. Arsdell. *Oil Gas J.*, 20.8.42, **41** (15), 32.—It is estimated that the maximum production of petroleum products in European countries under Axis control amounts to 53,501,000 brl. per annum, and the maximum production of synthetic and substitute fuels amounts to the equivalent of 81,720,630 brl. of petroleum products, a total of 135,221,630 brl. per annum. This is estimated to be 120 million brl. short of the estimated military and civil requirements of these countries on the basis of a full year of military operations on all fronts. Tables show the known Hydrogenation and Fischer–Tropsch plants operating in Germany and the location and capacity of known and projected synthetic fuel plants in Italy and France. Estimates are also given for each country of the maximum and minimum production, in terms of oil equivalents, of compressed gases, shale oils, benzol, alcohols, wood and coal-gas generators. Indications of the increasing use made of substitute fuels are given, and the practical limitations in production and utilization of some of these fuels are described. Details of Japanese production of petroleum and substitute fuels prior to her entry into the War are given, together with details of pre-war imports from foreign sources. R. A. E.

BOOK REVIEW.

Oil Well Drainage. By Stanley C. Herold. Pp. xv + 407, and 36 figures. Stanford University Press, Stanford University, California; London, Humphrey Milford, Oxford University Press, 1942. Price 30*s*.

In 1928 "Analytical Principles of the Production of Oil, Gas and Water from Wells" was published. While it was in the press one of Herold's colleagues at Stanford University suggested that when he had had an opportunity of verifying the mathematical theory presented therein, he should write another book without any mathematics, and make it easier to read by telling the story in simple language. The present volume has been written with the total exclusion of mathematical proofs of the propositions (apart from three geometrical proofs in the appendix), and with the inclusion of field examples of the circumstances described, the two ideas which met with the approval of all who were consulted during its preparation. It has been written for the particular attention of operators and owners of producing-oil and gas properties, and with the realization that it is impossible "to satisfy all types of individuals concerned directly with the oil and gas industry."

In addition to the complete avoidance of mathematical theory, Herold imposed upon himself the further restriction of a somewhat unusual lay-out for the book, which involves such features as confining the illustrations to diagrams forming the chapter headings, and the alternate discussion of each of the two types of drainage as the successive factors or groups of factors are dealt with, just as though the other type of drainage did not exist. The rigid adherence to this form, while giving uniformity and a very definite character to the book, makes it a little difficult to read, and in places causes the discussion to be longer and harder to follow than might otherwise have been the case.

The two types of drainage which are discussed are termed "Cenozoic" and "Palæozoic" after the eras in which each type is said to be most characteristically, though not exclusively, exhibited. The author realized that "there may be a question respecting the wisdom of applying the names of two geological eras to these types, particularly in view of outstanding exceptions to the classification." This, and some of the other terminology, is not entirely free from any possibility of causing confusion, although no succinct and entirely satisfactory alternatives readily present themselves. Gas drive and water drive are not respectively synonymous with Palæozoic and Cenozoic production since Herold considers that both drives—first one and then the other—occur within reservoirs of Cenozoic drainage, although gas drive alone exists in reservoirs of Palæozoic drainage.

The principal characteristics of the two types of drainage are as follows: (1) Cenozoic: The oil-producing formation outcrops in the foothills adjacent to the basin in which the field lies, and edgewater encroaches progressively in the field, wells being abandoned only because of edgewater trouble. A well may have an initial output of over 10,000 brl./day, and may produce naturally from year to year without decline, sometimes ultimately producing more oil than could possibly be present in the reservoir space underground in the area allotted to the well. The gas/oil ratio of a well reaches a peak within a year or so of the well's completion. Artificial gas or water drive is unsuccessful when the field is approaching exhaustion, and when gas is pumped back into the field the pressure at the input well falls, on standing, to the value obtaining before injection began. Screens may be necessary to keep sand out of wells. On plotting closed-in pressures and rates of production against time, with an early pair of simultaneous readings used as 100% for each set of data on the same scale, the rate curve lies above the pressure curve. (2) Palæozoic: There is no progressive encroachment of edgewater up structure, and wells may be abandoned in the middle of the field on account of exhaustion, without having had edgewater trouble. They may also be abandoned because of exhaustion while surrounding wells continue to produce from the same formation at profitable rates. The rate of production declines with the age of a well, and less oil is recovered than would fill the pores in the reservoir rock within the area allotted to a well. Artificial water or gas drive increases recoveries in old fields nearing exhaustion in

terms of primary recovery methods, and when gas is pumped back into the producing formation, on standing the pressure at the input well remains above the value prior to injection. Wells, old or new, may have high pressures at depth, while the surrounding wells, completed in the same formation, have low pressures. The pressure–time curve lies above the production rate–time curve when an early pair of simultaneous readings of pressure and rate of production are both plotted as 100% on their respective scales. Shooting may be needed to bring in a well, and its gas/oil ratio does not swing up to a peak in the first year or so of its life.

Each chapter except the first and last is divided into two parts, Cenozoic production being discussed in one part and Palæozoic production in the other. The main topics examined are as follows: typical artificial reservoirs; natural reservoirs; reservoir energy; the function of gas; the radius and area of drainage; regional drainage and water encroachment; drainage across property lines; the effects on drainage of stratigraphy and structure, reservoir penetration, multiple zones, rates of production and field development; drainage of wells of all or no gas; injection of gas, water or oil; reservoir content; ultimate recovery and reserves; abandoned oil and gas; curtailment, proration and conservation.

"Oil Well Drainage" is not a text-book on oil production, but a detailed discussion of the movement of oil to wells on the basis of two distinct mechanisms. Before reading the main body of the book it seems preferable that the preface and also the appendix (omitting the geometrical proofs) should be studied, for there are some points where the absence of appreciation of the author's intentions and of his realization of the existence of certain difficulties may engender an unsympathetic attitude.

In the examination of the various aspects of production and drainage according to the two mechanisms, attention has rightly been directed to many features which are apt to be overlooked or to be incorrectly assumed to occur in all fields. Frequently the examination is made from a new angle, and altogether the treatment is thought-provoking; but there are many instances where the presentation of the original field data and measurements, or at least where they have been published, the citation of the source, would have been more satisfying to readers, some of whom will probably want to ascertain how far data of their own agree with Herold's ideas.

G. D. Hobson.

BOOKS RECEIVED.

The Institution of Mechanical Engineers. Proceedings. Vol. CXLVII (January-June 1942). 11¼ in. × 8¾ in. 246 pages.

Comptes Rendus (Docklady) de l'Academie des Sciences de l'U.S.S.R. Vol. XXXV, No. 9.

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253. Crude Oils of New Mexico. E. C. Lane. *U.S. Bur. Mines Report of Investigations*, No. 3660, August 1942.—It is reported that the first important discovery of oil in New Mexico was made in 1909 near Dayton, Eddy County. Although wells were drilled in 1911 and 1912 in McKinley County, commercial production did not in fact begin until the discovery of Hogback Field, San Juan County, in 1922. It is only since 1930 that the State has ranked as one of the large producers, being sixth or seventh as compared with other States in recent years. Table 1 of this report shows production by years from 1924 to 1940, the figures being taken from the *Bureau of Mines Mineral Year Book*. Table 2 gives information as to the discovery of well production for 1940, and cumulative production for each field reported. A further table summarizes data showing sources of samples and some of the characteristics of crude oils from New Mexico. H. B. M.

254.* Regional Geology of Dakota Basin. N. Ballard. *Bull. Amer. Ass. Petrol. Geol.*, October 1942, **26** (10), 1557–1584.—The broad Dakota syncline is bounded on the east by the pre-Cambrian outcrops in Minnesota and the Sioux uplift, and on the west by the Black Hills pre-Cambrian and the Baker–Glendive anticline. It is wider and less deeply folded than the comparable Powder River basin in north-eastern Wyoming, and less elongated in a north-west to south-east direction.

Alluvium of re-worked shales and gravel may be the western and southern equivalent of northern boulder-clays. Silts of glacial Lake Agassiz along the Red River reach 100 ft. thick. Glacial drift (up to 500 ft.) thins westward, and does not reach beyond a north–south line west of the Missouri River.

The Tertiary includes White River (Oligocene) volcanic ash, pinkish clays, and calcareous sands (0–400 ft.), Fort Union sandy clays and lignitic sands (0–1200 ft.), and the Lance comprising the marine Cannonball and the lignitic Ludlow (together 0–300 ft.), as well as the very lignitic Hell Creek (up to 600 ft.), which at its base has small pebbles from the underlying Fox Hills (Cretaceous).

The Fox Hills formation (approx. 350 ft.) has, in its highest beds, many shells of *Ostrea glabra*, and passes with gradation downwards into the Pierre shale (1200–2000 ft.), in which the Eagle sand is a potential yielder in North Dakota, while the Shannon sandstone already produces oil in eastern Wyoming. Corresponding sands yield gas in the Baker–Glendive field, Montana. The Niobrara contains 200–325 ft. of impure chalk, grading into grey shale. Below it the Benton (about 250–1910 ft.) is of shales and some thin aragonitic fossiliferous limestones. The oil-bearing Wall Creek and Newcastle sands in Wyoming form part of the Benton. The sandstones of the Dakota group (0–725 ft.), above and below the Fuson grey to maroon shale member, yield oil in Wyoming and gas locally in the Dakotas. The base rests with major unconformity on the Jurassic.

The Canadian facies of the Jurassic contains grey marine shales in addition to red to maroon shales with anhydrite. It includes the Morrison (0–220 ft.) and Sundance (up to 735 ft.), and overlaps on bevelled edges of strata ranging down to the Devonian. The Triassic is represented by the Spearfish (up to 830 ft.) of red muddy sands. The Permian consists of the Minnekahta purplish grey finely crystalline limestone and dolomite with bituminous smell (40–60 ft.), and the Opeche ruddy shales and silts (60–160 ft.) with anhydrite. The Opeche–Minnelusa contact seems to be gradational.

The Minnelusa (Permo–Pennsylvanian) is up to 1335 ft. thick and comprises limestone, chert, dolomite, anhydrite, coaly and red shales, and grey to red sands of varying coarseness. It provides oil in the Williston basin of the Dakotas, and in Wyoming. It rests with great unconformity on the Big Snowy series (500–1450 ft.), which is mainly of grey limestone finely crystalline or oolitic. These beds are probably Upper and Middle Mississippian, and towards the west appear to contain the 6700 ft. oil-zone of the Baker–Glendive area. The Pahasapa limestone (Lower Mississippian) merges upwards into the Big Snowy group and downwards into the Englewood (Kinderhookian), which has Chattanooga-like shale with conodonts below it. Exposures at Wind Cave, Black Hills, show no discordance of dip between the Englewood and underlying Deadwood (Cambrian). Siluro-Devonian lithographic dolomite with streaks of leached green shale occur in south-eastern South Dakota;

and in Williams County, North Dakota, it is believed that 635 ft. of these beds have been penetrated. In the eastern half of South Dakota, Devonian dolomite with rounded frosted grains of quartz overlaps the Ordovician.

The Ordovician includes, Whitewood limestone, Decorah shale, and St. Peter (?) sandstone. Beds of Beekmantown age (Lower Ordovician) are not recognized. The Deadwood (Cambrian), which ranges from 233 to approx. 500 ft., includes glauconitic fucoid-bearing sandstone, shales, and dolomitic limestone with basal conglomerates.

The undermentioned epochs of tilting and folding are indicated:

Post-Oligocene.	
Post-Fort Union.	
Possibly post-Fox Hills, pre-Lance.	
Post-Morrison, pre-Lakota.	
Post Spearfish, pre-Sundance.	
Post-Chester, pre-Pennsylvanian.	
Post-Devonian, pre-Mississippian.	Near or in area of Sioux uplift
Post-Silurian, pre-Devonian.	
Post-Galena, pre-Silurian.	
Post-Beekmantown, pre-Chazy.	
Post-Deadwood, pre-Decorah.	
Pre-Cambrian folding.	

Pre-Cretaceous and pre-Pennsylvanian paleogeological maps are provided.

A. L.

255.* Interbasin Pennsylvanian Correlations, Illinois and Iowa. J. M. Weller, H. R. Wanless, L. M. Chine, and D. G. Stookey. *Bull. Amer. Ass. Petrol. Geol.*, October 1942, **26** (10), 1585–1593.—A 350-ft. Pennsylvanian section in adjacent parts of Illinois and Iowa has been correlated bed by bed. At the bottom, the composite Seahorne cyclothem (Middle Cherokee) of western Illinois is equivalent to the Munterville limestone of southern Iowa. Succeeding coals, and fusulinid and other marine as well as non-marine limestones are readily linked up, and cover the whole of the Des Moines series. At the top, the Trivoli limestone, in Illinois, is synchronous with the Hertha limestone, in Iowa. The Hertha has the earliest specimens of *Triticites*, and is the lowest limestone of the Missouri series. The Trivoli, albeit without fusulines, lacks characteristic Des Moines fossils such as *Mesolobus* and *Prismopora*. Several of the sandstones are of a channel-filling nature. A. L.

256.* Chester Sandstones Producing Oil and Gas in Lower Wabash River Area, with Special Reference to New Harmony Field, Illinois and Indiana. G. V. Cohee. *Bull. Amer. Ass. Petrol. Geol.*, October 1942, **26** (10), 1594–1607.—The New Harmony field, discovered in June 1939, lies along the lower Wabash River. It has developed rapidly, and, by the end of 1941, covered 5000 acres with 647 wells which had then produced 11,700,000 brl. crude oil. Future reserves are put at 20 million brl. If we include the Keensburg field the productive area is about 18 ml. long from north-north-east to south-south-west and from ½ to 2 ml. wide, and occurs on a broad, slightly folded anticline. Oil and gas usually occupy local highs, but productive areas in individual sands depend more upon sand characteristics than on tectonic structure.

The main yield is from Chester (Upper Mississippian) sandstones, including the Bethel, productive over 3300 acres; the Aux Vases, productive over 2640 acres; the Cypress, productive over 2000 acres; while the Waltersburg, Tar Springs, and Paint Creek-Bethel yield from 750, 480, and 440 acres respectively. Other production is from the basal sandstone of the Lower Pennsylvanian, and from the Fredonia (= McClosky) limestone of the Ste. Genevieve formation (Lower Mississippian).

The Chester sands are mainly fine-grained, usually with siliceous cement, but the Aux Vases (= Rosiclare sandstone of Hardin County) has varying amounts of calcareous matrix, which may be so abundant as to render parts of the sandstone impermeable. In the southern area of the field, Aux Vases wells are shot with 600 or more quarts of nitroglycerine.

These fine sands were apparently deposited near shore in advancing Chester seas, and may have been supplied from a low-lying land mass by large streams of low gradient. Current and wave action contributed to re-work unconsolidated alluvial

material. Sandbars and irregular sand deposits, formed as lenticular and disc-shaped bodies—cf. C. Bower, *Bull. A.A.P.G.*, June 1928—which grade laterally into siltstone and shale, were preserved by later sedimentation in the transgressing sea. A. L.

257.* Crocker Flat Landslide Area, Temblor Range, California. R. R. Simonson and M. L. Krueger. *Bull. Amer. Ass. Petrol. Geol.*, October 1942, **26** (10), 1608–1631.—In the Crocker Flat–Recruit Pass area of the Temblor Range, north-east of the San Andreas fault-zone, structures previously described as a low-angled overthrust sheet, and succeeding fanglomerate lenses containing granitoid and schistose boulders, are shown to be due to large-scale landslips which took place during the Upper Miocene.

Following late Antelope orogeny which exposed sands and shales of the Vaqueros (Oligocene) and Temblor (Lower Miocene) as well as Gould shale (Middle Miocene) along an uplifted axis corresponding with the San Andreas fault-zone, slipping due to gravity brought a crumpled sheet of these earlier Tertiaries to rest upon the McDonald and Antelope shales (Upper Miocene).

Erosion followed this primary Crocker Flat landslip, and there was also uplift of much older basement rocks on the south-west side of the San Andreas fault. From the upraised massif, Santa Margarita (Delmontian = highest Upper Miocene) sediments were derived which rest everywhere on an unconformity. Towards the south-west they consist of: (1) the coarsest types of talus, which give place north-eastwards to (2) conglomerates in a sandy matrix, which in turn interdigitate with (3) finely bedded, punky diatomaceous shales which are interleaved with lensing cobble-beds. (2) and (3) buried the "fossil Crocker Flat landslide."

Later folding and erosion isolated the slumped Temblor–Vaqueros shales and the boulder-beds from their sources. Uplift on the north-east side of the normal Recruit fault, to which elevation of the Temblor Range is largely due, has also left much of the travelled material now in a higher position than that of the eroded stumps of the hills from which it was derived. A. L.

258.* Payton Pool, Pecos and Ward Counties, Texas. R. E. Gile. *Bull. Amer. Ass. Petrol. Geol.*, October 1942, **26** (10), 1632–1648.—Discovered in November 1937, by September 1, 1940, Payton Pool had yielded 1,700,000 brl., or 1280 brl./acre, from 134 producing wells. The oil is from upper and lower pay-zones, separated by a 60-ft. dolomite, in the Yates formation (240 ft.), of the Guadalupe series (Permian). The oil-sands are interbedded in red and green shale. A north-west–south-east elongate dome controls the presence of gas or oil, but lateral gradation eastward from sand into sandy shale and anhydritic sand determines production. Improvement is usually obtained by shooting the wells with nitroglycerine.

The earlier wells yielded from 35 to 305 brl./day of natural flow. Originally there was a gas-cap under high pressure, and the bottom-hole pressures in the upper and lower pays respectively were 1014 and 1132 lb./sq. in. By September 1940, after production of 2844 brl. per lb. drop in bottom-hole pressure, the average was 412 lb./sq. in. Water encroachment has not kept pace with withdrawals, so that gas-expansion is mainly responsible for moving the oil to the borings. In September 1940, forty wells had natural flow, twenty-nine were on gas lift, fifty were being pumped, and ten were defunct.

Ultimate recovery, based on cumulative production and rate of decline of pressure, is estimated at 3,500,000 brl. or 100 brl. per acre-foot of saturated sand. A. L.

259.* Amoura Shale, Costa Rica. P. P. Goudkoff and W. W. Porter. *Bull. Amer. Ass. Petrol. Geol.*, October 1942, **26** (10), 1647–1655.—Foraminifera from samples of shale on the Amoura River, a few metres from the mouth of Uscari Creek, Talamanca Province, on the Caribbean side of Costa Rica, are of Oligocene or Lower Miocene date, and are older than the Uscari formation as known in the works of Olsson and Woodring. Abundance of *Orbulina*, *Planulina*, and *Robulus* indicates deposition in temperate waters "at a depth above the continental shelf and under open-sea conditions." There are marked affinities with the microfauna of Mante, Ecuador, and also with the Zemorrian stage (Oligocene or Lower Miocene), California.

At the tip of the Nicoya peninsula, between Cape Blanco and Ballena Bay, on the

Pacific coast, gently dipping littoral beds rest on a basaltic basement. Samples of siltstone and clay with rounded fragments of molluscan shells and pebbles contain relatively brownish-stained Foraminifera—*Uvigerina gardnerae*, *Nonion*, *Planulina*, *Pyrgo*, *Robulus*—which are probably re-worked from Eocene or Oligocene sediments. There is also a much more abundant indigenous fauna, all of a white colour, consisting of *Amphistegina*, *Bolivina*, *Elphidium*, *Eponides*, and *Quinqueloculina*, which indicate Miocene of a younger date than the assemblage from the Amoura shales. *Amphistegina* and *Elphidium* suggest warm, shallow waters. A. L.

260.* Preparation of Lantern-Slide Copy. C. A. Moore. *Bull. Amer. Ass. Petrol. Geol.*, October 1942, **26** (10), 1656–1671.—Familiar defects in lantern-slides are: (1) lettering too small; (2) figures and lines, including grid-lines, too crowded; (3) lack of contrast between lines and background; (4) lettering copied from typescript not solid black, but consisting of separated impressions of threads of a typewriter ribbon; (5) too much glaring white background and margin which cause contraction of the pupil and so reduce visual appreciation.

According to the ophthalmological charts of the American Optical Company, letters of 1·75 in. in height are visible to normal eyes at a distance of 100 ft. The ratio of height to distance for visibility is thus

$$\frac{1{\cdot}75}{1200},$$

or 0·0015 (approx.). From this Arthur Knapp has derived his formula for determining the minimum size of lettering required on slides:

$$h = 0{\cdot}0015\,\frac{Ac}{P},$$

where h = height of letters in inches, A = maximum distance of audience in feet, c = width of original copy in inches, and P = width of projection on screen in feet. For instance, on the assumption that the rearmost onlooker is to be 50 ft. away, that the original copy is 20 in. wide, and that the width of projection is 7 ft., the minimum height of the letters should be 0·21 in.

"Negative slides" with white lines on a black background give best visibility, since with such slides the retinal opening is least contracted by glare, and ocular fatigue is reduced to a minimum. Unfortunately, where projection of the same slide is continued for a considerable period, such slides absorb too much light and heat from the bulb, so that usually they are only suitable where the slides are changed in quick succession. A. L.

261.* Late Palæozoic Age of the Morehouse Formation of North-eastern Louisiana. R. W. Imlay and J. S. Williams. *Bull. Amer. Ass. Petrol. Geol.*, October 1942, **26** (10), 1672–1673.—The Morehouse formation, comprising 1190 ft. of dark silty shale and thin siltstones of carbonaceous, siliceous, or finely micaceous, less commonly calcareous, nature, occurs at depth under the Eagle Mills salt, anhydrite, and red shales. On the evidence of a sponge, Imlay (1941) placed it in the Jurassic, but fifty external and internal moulds of molluscs have now been obtained which have a late Palæozoic aspect.

Special importance is attached to a member of the Bellerophontacea, identified as *Patellostium* sp. The genus ranges from Devonian to Permian, but the Morehouse specimens have distinctive ornament like that of *P. montfortianum* Norwood and Pratten, which has recently been made the genotype of *Cymatospira* Brookes Knight. This resemblance suggests that the age is not greater than Pennsylvanian.

The Morehouse appears to introduce us to deposits of the southern part of the Ouachita geosyncline. Such Palæozoics are less favourable for oil than the local Mesozoic strata. A. L.

262.* Petroleum Development in Canada. Part 2. F. K. Beach *Petrol. Engr*, November 1942, **14** (2), 54.—Outcrops of bituminous sand extend for 65 ml. along the Athabaska River, and for perhaps 40 ml. to the south-west. In places they are 200 ft. thick. These sands, possibly of Cretaceous age, rest on Middle Devonian limestones, and may be of deltaic or estuarine origin. The bitumen impregnation is

irregular, but the total estimated bitumen content is probably such as to make the sands the greatest single oil reserve in the world. Commercial development of the sands was attained only in 1941, when 20,000 brl. of oil were separated, and fractionated into products ranging from gasoline to fuel oil. In working, the sand is shattered by explosives and conveyed to vats, where the addition of hot water allows the removal of much of the sand, while dilution of the oil with a light oil enables most of the remaining inert matter to be extracted. The oil has about 5% of sulphur which is not in a corrosive form. Tests are being made on the production of bitumen for paving.

Geophysics and shallow drilling are being used to search for favourable structures in Alberta, for most of the province has a mantle of glacial drift. The magnetometer method has not proved successful, but the gravity meter may be useful. The presence of glacial drift has made the interpretation of seismic work difficult, due to uncertainty about weathering corrections in some areas. So far the discoveries in the plains have been mainly in the Mesozoic. Production is dependent on local conditions in continental beds, and not on the usual structural trapping features. Better results may be obtained in the underlying Palæozoic beds.

Alberta's main oil production comes from Turner Valley in the foothill belt. The first distillate production from the Palæozoic limestone was obtained in 1924, but it was only in 1936 that the first crude-oil producer was completed well down the western flank of the structure. Now there are 192 oil-wells, and the field is 20 ml. long and up to 1½ ml. wide, with the gas-cap on its eastern margin. At present the production is about 27,000 brl./day. Up to the end of 1941 33,500,000 brl. of oil had been produced, with an overall gas/oil ratio of 3500 cu. ft./brl. The individual gas/oil ratios depend on the position and treatment of the wells.

Details are given of the drilling and completion practices.

The porosity and permeability of the reservoir limestone are erratic. Two or three porous zones are present in some parts of the field. The depletion characteristics of the wells are better criteria than the reservoir porosities from which to estimate reserves. G. D. H.

263.* Well Completions Drop off During October. Anon. *Oil Wkly*, 9.11.42, **107** (10), 142.—Well completions, after having risen above the 400-per-week level in September, dropped slightly below 400 per week in October. There were considerable decreases in the numbers of completions during October in Kansas, Mississippi, Ohio, New York, Pennsylvania, and West Virginia.

The 18,004 wells completed in the first ten months of 1942 were 32% below the corresponding figure for 1941, but it seems likely that the year's total will appreciably exceed the 19,000 set by the Government as necessary to sustain the U.S. producing ability.

On 1st November, 1942, 2185 wells were drilling, compared with 2124 on 1st October, 1942. This increase was largely due to California, Illinois, Indiana, and Kentucky, where restrictions have been relaxed. The wildcat total is smaller than desired.

Tables give by States the drilling activity on 1st November, 1941, 1st October, and 1st November, 1942; details of the completions in October 1942, and of the cumulative completions in the first ten months of 1942. G. D. H.

264.* New Oil- and Gas-Fields and New Pay Horizons Discovered in the United States in October. Anon. *Oil Wkly*, 16.11.42, **107** (11), 48–52.—The discoveries are grouped according to States, and subdivided according as they represent new fields or new pay horizons. The data are presented in tabular form, and include the name of the field, the county, the location of the discovery well, and the name of the company which drilled it; its distance from the nearest field and pipe-line; the date on which the well was spudded, and the date on which it was completed; the total depth of the well; the type of structure and the method of discovery; the name, nature, and age of the producing formation; the depth of the pay; the method of initial production and the amount of oil obtained in 24 hr.; the oil gravity and a preliminary estimate of the ultimate production. G. D. H.

265.* **Wildcatting Results Fall Short of Expected Required Drilling.** Anon. *Oil Wkly*, 16.11.42, **107** (11), 52.—During October the results of wildcatting in the U.S.A. fell materially below the development hoped for in the programme of the minimum necessary drilling for 1942. Of the 19,000 wells expected to be drilled it was calculated that 4000 should be wildcats, of which 624 should produce oil and 116 gas, while the remainder failed. These figures are equivalent to an average of 333 wildcats per month, with fifty-two giving oil and ten gas. Only 235 wildcat wells were completed in October. Thirty-two new oilfields were discovered, one new distillate field, and twelve new pays in established fields. Five new gas-fields were found. Over half the new oilfields were in Oklahoma, Kansas, and Illinois, where discoveries are commonly pools of limited area and importance. The three States furnished respectively seven, five, and five new fields. Texas had seven new fields, Kentucky, Michigan, and Montana two each, and Indiana and South Louisiana one each. A new gas-field was found in each of the following areas: Indiana, Kansas, New Mexico, South Louisiana, and the Lower Texas Gulf Coast. Five new pay horizon discoveries were made in Texas, three each in Illinois and Oklahoma, and one in Wyoming.

Relatively few of the discoveries were in districts commonly supposed to have possibilities of yielding important fields. G. D. H.

266.* **Location of Reserves Big Factor in Supply Deficiency. Part 2.** W. V. Howard. *Oil Gas J.*, 26.11.42, **41** (29), 18.—In October the Illinois–Indiana–Missouri area had a deficiency of 218,000 brl. of crude/day with regard to its normal demand of 500,000 brl./day. On 1st July, Illinois had estimated reserves of 5·1 years' production calculated on the basis of the output during the first half of 1942. At the current reduced rate of production the reserve in terms of years' supply has been slightly increased.

Oklahoma, Kansas, and Nebraska produced 332,000 brl. of crude/day in excess of refinery needs in October 1942. During 1941 and the first half of 1942 the Kansas output was at the rate of one-ninth of its estimated reserves annually, but since July the discovery rate has fallen, and the present production rate is $\frac{1}{7 \cdot 3}$ of the estimated reserve. There seems to be little possibility of increasing the production rate of Oklahoma's present fields, and recent discoveries have not been of major importance.

The North Louisiana production rate has risen nearly 20% since October 1941, but most of this gain has been offset by a reduced output in the Louisiana coastal region. North Louisiana's hopes of increased production centre round deep pays in such fields as Haynesville, and added discoveries at the eastern end of the Wilcox trend. Coastal Louisiana's decline is almost entirely due to transportation difficulties. The Lower Cretaceous and Jurassic possibilities of Arkansas and North Louisiana are far from exhausted.

Texas and New Mexico have nearly 60% of the U.S. reserves, but provide only 37% of the current production. 20% of the Texas output is from districts (Laredo, San Antonio, East Central, West Central, and North Texas) with wells averaging less than 12 brl./day, and except for Laredo these districts cannot be expected to give much additional production. The East Texas field gives most of the East Texas district oil, and no increased production can take place there until an adequate water-disposal scheme is in operation. The rate of production in the Texas coastal fields could be increased. Since October 1941 the output of West Texas and New Mexico has fallen 100,000 brl./day, but this production could be restored and a further 150,000 brl./day could be added with safety and maintained for two years. Major discoveries may be expected in the Permian Basin and South Texas.

The reserve situation in Colorado and Montana is good, and their production could be increased, though not sufficiently markedly to affect the national output. Wyoming has many undrilled structures, and lack of markets has held back much potential production.

The estimated future relationship between refinery runs and production is tabulated for the various districts.

Unless additional drilling is encouraged any sudden increase in demand would cause a production crisis with far-reaching effects. G. D. H.

267.* **October Completions Down 51·2% from Last Year.** Anon. *Oil Gas J.*, 26.11.42, **41** (29), 180.—The U.S.A. well completions numbered 1451 in October, ninety-one

fewer than in September 1942, there being 830 oil-wells and 172 gas-wells. There were 2242 active rigs and drilling operations. Drilling in California has steadily increased during the past few weeks, and the October total of ninety-nine completions was the highest since January. This increase is partly due to renewed drilling in old shallow areas such as Coalinga, Midway-Sunset, Kern River, and Belridge.

A table summarizes the operations in October 1942 by States, with data about depths, type of well, etc. G. D. H.

268.* California Operators Turn to Old Shallow Fields for New Oil. L. P. Stockman. *Oil Gas J.*, 3.12.42, **41** (30), 12.—The December allowable for California is 815,000 brl./day, calling for the production of 45,000 brl. of natural gasoline and distillate, and 770,000 brl. of crude/day. It is likely that the 1943 demands will be substantially higher than this, and, when the maximum efficient rate of production has been reached, further increases in output will call for additional drilling or the ignoring of the matter of efficient rates of production.

While the number of discoveries has been maintained, the productivity of the fields found in the last four years has been negligible, and few deep zone discoveries have been made. (While the Stevens zone discovery at Elk Hills is important, it will be held back by the Navy Department.)

Lately there has been widespread development in the older fields where additional drilling is justified. Most of the present drilling in the San Joaquin Valley is in shallow fields. At South Belridge a number of wells have been completed in the 800-ft. zone in less than a week, yielding oil from Pleistocene beds or from the Pleistocene–Pliocene contact. Fifteen new wells with an aggregate output of 1209 brl./day have been completed at Kern Front. The thirteen new wells at East Coalinga have a total output of 2139 brl./day. Seventeen rigs are active at Midway-Sunset, and increased drilling is going on at Mount Poso and Round Mountain. G. D. H.

269. November Completions Lowest since Spring. Anon. *Oil Wkly*, 14.12.42, **108** (2), 41.—During the five weeks ended 28th November, well completions averaged 370 per week, the lowest figure since April. The weekly rate of completions in November fell in California, Colorado, Montana, Wyoming, New Mexico, Arkansas, Kansas, South Louisiana, Oklahoma, North, East, and West Texas, Illinois, Indiana, Michigan, and Pennsylvania. There were increased weekly averages in Kentucky, Ohio, New York, West Virginia, North Louisiana, and all southern and coastal districts of Texas. It seems likely that the Government's objective of 40% curtailment of drilling in 1942 will be achieved.

Tables give by States and districts details of drilling operations on 1st December, 1941, and 1st November and 1st December, 1942; also the completions, types of completions and footage drilled in November 1942, with the well totals for November 1941, October 1942, and for the first eleven months of 1942. G. D. H.

270. Kentucky's New Burbank Field Producing 8000 brl. Daily. W. R. Jillson. *Oil Gas J.*, 17.12.42, **41** (32), 18.—On 7th August, 1942, the exploratory well 1 Burbank was completed in north-west Henderson County as an important producer in both the Cypress and the McClosky. After four months of development twenty wells (seventeen producers) have been completed, and the field's flush production is over 8000 brl./day. The wells have ranged 250–800 brl./day initially, with an average of about 500 brl./day from depths of 2300 ft. The discovery well was credited with 150 brl./day from the McClosky at 2674–2683 ft., and about 300 brl./day from the Cypress at 2303–2320 ft.

Beneath the alluvium Pennsylvanian beds extend to a depth of 1500 ft. The underlying Chester (Mississippian) limestones, sandstones and shales occur and include the principal oil and gas horizons of western Kentucky and southern Illinois. Beneath are Middle and Lower Mississippian beds, some Devonian, Silurian in places, and Ordovician. The oil-producing possibilities of the Middle and Lower Palæozoic are unknown, due to lack of exploration.

The normal dip of the Palæozoics between Henderson and Union County is 25–30 ft./ml. to the north-west, but there are local flexures which frequently control oil and gas accumulation. There may be a local anticline at Burbank, for synclines occur to the north and south, and they run together at Smith Mills. This belief is supported by the wells drilled so far. G. D. H.

271. November Completions Show Steady Decline in Drilling. Anon. *Oil Gas J.*, 24.12.42, **41** (33), 60.—In November 1353 wells were completed, considerably fewer than in the previous four-week period, for there were sixty-five fewer oil-wells and twenty fewer gas-wells. Compared with November 1941 the drilling was down by 51·6% and the number of oil-wells down by 59·7%.

A table summarizes by States and districts the completions during November 1942, giving the numbers of completions in each category (oil, gas, or dry), the footage, and the numbers of wells in various depth ranges. G. D. H.

272. Chinese Open Oilfield far Behind Battle Lines. Anon. *Oil Wkly*, 28.12.42, **108** (4), 48.—An oilfield has been located by surface geology and seepages at an undisclosed spot far behind the battle front in China. The wells are drilled to a depth of about 1500 ft. They show little gas, but considerable hydrostatic pressure is reported. Glacial drift up to about 150 ft. in thickness covers the area. G. D. H.

273. Turner Valley Reaches Peak this Year. Anon. *Oil Wkly*, 28.12.42, **108** (4), 48.—Turner Valley gives 97% of the Canadian oil output, and in 1942 it will surpass all its previous records. In the first ten months of 1942, Alberta produced 8,478,354 brl. of oil, and it is estimated that the total for 1942 will be 10,478,354 brl. The Alberta output has risen rapidly since a prolific oil-flow was found in the South Turner Valley limestone in June 1936.

Vermilion, the most productive field outside Turner Valley, gave 6979 brl. from fourteen wells in October, Taber 6086 brl. from two wells, Red Coulee 839 brl. from seven wells, Wainwright 1347 brl. from seven wells, Princess 1384 brl. from one well, Del Bonita 391 brl. from one well and Tilley 236 brl. from one well. G. D. H.

274. Unsatisfactory Exploration Status Demands Attention. E. De Golyer. *Oil Wkly*, 28.12.42, **108** (4), 15.—The U.S.A. exploratory effort, as measured by the number of wildcats and by the number of geophysical crews and core-drill crews operating, is an all-time high. More than 3000 wildcats were completed in 1941, and in the first ten months of 1942 some 222 seismic crews and twenty-nine core-drill crews were in the field. Intelligently directed exploratory effort is being more widely expended than ever before, but the results obtained are inadequate. For the past four years new discoveries appear to have been at the rate of 500,000,000 to 600,000,000 brl./year, against an annual consumption of substantially more than 1,000,000,000 brl. Proved reserves are of the order of 20,000,000,000 brl., and if they were suitably located and recoverable at the required rate, they would meet the war programme, but this is not so. Even now the excess producing capacity is largely in areas with inadequate transport facilities.

This unsatisfactory condition is mainly due to the failure to find large fields at the same rate as in the past. From 1934 to 1938 an average of 121 new fields were found annually, with an average estimated reserve of 15,000,000 brl. each. For 1939 to 1941 inclusive, the average was 242 fields/year, with an average estimated reserve of less than 3,000,000 brl. each, due to the absence of the 100,000,000 and 200,000,000 barrel fields which had raised the average reserve in the previous period. While the number of fields found annually has been increasing since 1934, their average reserve has been falling.

Up to the present, the bulk of the scientific and technical skill has been concentrated on finding structural traps. It appears that the structures now being found in known petroliferous provinces are very small. This suggests that the discovery of stratigraphic traps must be depended on to maintain production, unless prolific new areas are opened. The discovery of a stratigraphic trap generally requires much more drilling than the discovery of a structural trap. Thus, since many of the new pools will probably be stratigraphic traps, extensive wildcatting is needed. Every possible method of discovery must be employed. Existing geological and geophysical data must be re-examined and re-appraised; greater risks must be taken. Areas which seem favourable for accumulation must be explored for structural prospects, and there are quite a number which have not been covered by detailed surveys of the highest resolving power. This condition exists in producing as well as in non-producing States.

The future discovery cost of stratigraphic and structural traps may easily be at

least twice as high as the present cost of 20–35c./brl. shown by some successful companies. G. D. H.

275. Four Attacks Proposed to Enhance Oil Exploration. E. De Golyer. *Oil Gas J.*, 24.12.42, **41** (33), 13.—See preceding abstract. G. D. H.

276. World Oil Industry Has Weathered Impacts of a Year's Global War. S. Norman, *Oil Gas J.*, 31.12.42, **41** (34), 38.—Tanker losses and lengthened supply lines have been the chief reasons for the most radical changes in production, but lack of steel has also played a part. While reliable data are lacking, Germany's reserves are believed to be being seriously depleted. Venezuela's output has fallen by over 78,000,000 brl., due to shortage of marine transport.

Trade agreements have been concluded between Mexico and U.S.A., which should improve the position of the oil industry in the former country. Argentina's production has risen 8–9%. Trinidad has discovered one new field since war began, but the bulk of its 75,000–100,000 brl./day production is from its old fields.

Rumania's 1942 production may not exceed 30,000,000 brl., compared with 43,231,000 brl. in 1941, while her exports to Germany may have fallen 10–15% to 20,000,000 brl. The Lipse field of south-west Hungary is reported to be giving 2,500,000 brl./year. Operations are said to have been accelerated at Zisterdorf, Gbelly, Pechelbronn, Kutina, and Saint Marcet, oilfields within the territory now occupied by Germany.

Some sources state that several large refineries in north France are being removed to the interior of Germany to make them less vulnerable to air attack.

A table gives the estimated oil production of the various countries in 1942, and sets out the 1941 figures for comparison. G. D. H.

277. Reduction in Oil Production Caused Entirely by Warfare. J. P. O'Donnell, *Oil Gas J.*, 31.12.42, **41** (34), 42.—During 1942 the world oil output probably amounted to 2,056,900,000 brl., 170,225,000 brl. less than in 1941. This is the largest decline in history. While 75,000,000 brl. were lost as a result of destruction in the south-west Pacific area and at Maikop, 125,000,000 brl., almost all of it in the western hemisphere, were lost as a result of lack of transport. Venezuela's output fell by nearly 80,000,000 brl., entirely due to lack of transport, while the potential output has increased.

Widespread destruction in Burma and much of the East Indies has certainly reduced the production of those countries to small proportions.

During 1942 Colombia's production was only 43% of the 1941 figure, the rate having fallen from 83,500 brl./day in February to 6500 brl./day in October. This decline is due to lack of outlets.

The loss of the Maikop fields has no doubt increased the rate of exploitation of the Ural–Volga fields, and it seems unlikely that the Soviet loss of oil or of means of transport on the Volga has been sufficient to impair their ability to resist or to take the initiative.

Hungary's production is estimated at 12,000 brl./day, and probably shows the greatest rise in oil production among those countries controlled by Germany. Rumania's output is believed to have declined again in 1942.

Production has increased in the Near East, demands for oil from this region having risen since the loss of the Far East fields. Production also rose in Trinidad, Peru, and Argentina, while it fell in U.S.A., Mexico, and Colombia. G. D. H.

278. Colombia's Casabe Field Showing Major Caliber. E. Ospina-Racines. *Oil Gas J.*, 31.12.42, **41** (34), 60.—The Infantas and La Cira sands of the De Mares concession, due east of the Casabe structure, range 50–200 ft. in thickness. The lenticular Casabe sands are several times thicker. 5 and 6 Casabe have been brought in with natural flow of 1200 brl./day and 1000 brl./day respectively.

The El Doce test, located 125 ml. from the Caribbean, was abandoned in the basement rocks at a depth of 10,046 ft. On an adjacent tract El Dificil has encountered considerable gas pressure.

750 ml. inland, in the Llanos region, are the Culimba and Braval tests, which penetrated the Cretaceous without positive showings of oil or gas. In this area a number of structural holes have also been drilled. Extensive geophysical work has been carried out.

In the middle Magdalena valley the MacCarthy well was abandoned at a depth of 5438 ft. No. 1 Cimitarra showed some gas and oil. On the Gutierrez tract just north of the Yondo block, two unsuccessful tests were drilled. The Infantas and La Cira structures have been completely delimited by drilling, over 298,441,666 brl. of oil having been produced since 1921.

The Petrolea field of the Barco concession has 137 wells, which have fully delimited the structure. The Socuavo structure may develop into Colombia's largest field. Two wells have been completed and a third begun. The Tres Bocas field also shows good promise.

The Sagoc pipe-line may ultimately be able to transport 26,000,000 brl. of oil/year. It is estimated that within ten years Colombia's oil production may be doubled, and so equal 50,000,000 brl./year, provided that the oil discoveries are suitably located and that a crude-oil market is available. 87·5% of the 1941 output was exported.

Tables give data about the wildcats drilled since the passage of and under Law 37, details of which are given; about the decline in oil production in the first ten months of 1942; and about the oil concessions as of July 1942. G. D. H.

279. Argentina's Increasing Oil Production Big War Asset. Anon. *Oil Gas J.*, 31.12.42, **41** (34), 66.—Argentina's 1942 oil output will be about 3,840,000 metric tons, compared with 3,499,757 metric tons in 1941, when 64% of the total was Government production.

Argentina has over 3000 oil-wells and about 100 gas-wells. 364 new wells were drilled in 1941, 228 by the Government. The nineteen refineries have an annual capacity of about 4,800,000 metric tons. The country possesses thirty-one tankers with a total tonnage of some 85,000 tons.

Argentina is ninth on the list of oil-producing countries, but it has to import crude oil and refined products. In 1934 two-thirds of the country's output was in the hands of private owners. Now the position is reversed, and the Government wells provide two-thirds of the output. The cash value of the oil imports fell by 36% between 1929 and 1939.

The principal oil-producing regions in Argentina are Comodoro Rivadavia, Mendoza, Plaza Huincul, Salta, and Jujuy. Comodoro Rivadavia produced 1,450,000 metric tons of oil in 1931, and 2,100,000 metric tons in 1940.

In 1941 14·91% of the country's oil was imported. 799,000,000 cu. m. of natural gas were produced in 1941. The war has restricted oil imports, leading to shortages, and the Government is now being urged to drill additional wells on the reserved lands in order to increase the national oil production. G. D. H.

280. Extensive Development Plans Launched in Northern Canada. Anon. *Oil Gas J.*, 31.12.42, **41** (34), 103.—Tentative plans are being made for drilling about 50 ml. north of Fort Norman. Also, additional production may be developed at Fort Norman, and a 400-ml. pipe-line laid westward to Whitehorse, where a refinery would be built. This would ease the oil problem for activities in Alaska.

Production was developed in the Fort Norman area over twenty years ago, but its isolation prevented much expansion. The wells are east of the Mackenzie river, and near a seep. The oil is in Upper Devonian beds, the first well being completed at a depth of 990 ft. The second well was completed at a depth of 1602 ft. in 1925. The rate of production has been determined by the needs of local mining operations, and in 1939 about 20,000 brl. were produced. A new topping plant capable of handling 800 brl./day is planned. G. D. H.

281. Agua Caliente Field in Peru Could Deliver Oil via Amazon. Anon. *Oil Gas J.*, 31.12.42, **41** (34), 107.—There is a potential daily production capacity of 2500 brl./day at Agua Caliente, east of the Andes and 2800 ml. from the mouth of the Amazon. Owing to war conditions it has not been possible to get barges for transporting the oil down the Amazon, which is the easiest route for moving the oil from the field.

Brazil holds the key to the successful operation of this field, since Brazilian law requires all refining and exploratory operations to be carried out by Brazilian nationals, and it is uncertain whether this ruling applies also to transportation through Brazil.

The Agua Caliente series of sandstones and shales outcrops on the crest of the structure. It is probably of upper Middle Cretaceous age, and it includes the oil-zones. Six wells have been drilled to prove about 640 acres. G. D. H.

282. Tres Bocas–Socuavo Wildcats Open New Colombian Production. Anon. *Oil Gas J.*, 31.12.42, **41** (34), 121.—The cessation of export-crude movements stopped production almost completely at Petrolea. Encouraging results have been obtained in wildcat operations on the Tres Bocas–Socuavo structure, north of the Petrolea field. Two wells testing the Cretaceous at depths of 9000–10,000 ft. found some distillate production. Socuavo 1 on the crest of the northern part of the structure is not rated as a commercial well, but A-2 Tres Bocas, 8 ml. to the south and west of the crest, flowed at the rate of more than 1000 brl./day. Two tests of the Tertiary in the 4000–5000-ft. range have been drilled on the same structure. Socuavo 2 on the west flank, 4 ml. north of Socuavo 1, produced 200 brl./day, and No. 3 Tres Bocas, about 14 ml. south of 2 Socuavo, and on the east flank, pumped a smaller amount of oil mixed with water. G. D. H.

283. Bolivia is Expanding All Phases of Oil Operations. Anon. *Oil Gas J.*, 31.12.42, **41** (34), 128.—Bolivia's four oilfields are to be rehabilitated and developed, and exploration for further reserves is to be undertaken, with a view to trebling the country's output in the next two years. The present production is about 1900 brl./day, over half of it coming from the Bermejo field. Earlier in 1942 two wells were giving 500 brl./day at Camiri, and seven wells 380 brl./day at Sanandita. Pipe-lines are to be built to make the oil available for industrial and mining operations. A 2000-brl./day refinery is to be built at Oruro to provide oil products for mining operations. The capacity of the Camiri topping plant will be increased to 500 brl./day.

Camiri produces 53·1-gravity oil from the Devonian at a depth of 3200 ft. 640 acres have been proved, while the total productive area may be 5000 acres. 200 acres have been proved at Sanandita, and this field may cover 1800 acres. Camatindi has been shut in since 1931. 3200 acres are potentially productive, although only 1120 acres have been proved. Bermejo has three pays at depths of 2200 ft., 2850 ft., and 3600 ft. It covers 2560 acres, and may extend to 11,500 acres. A contract has been signed for the production of 1000 brl./day from Bermejo for Argentina.

G. D. H.

Geophysics.

284. Progress in Exploration. Anon. *Oil Gas J.*, 31.12.42, **41** (34), 172.—There are indications of a revival in the use of magnetic and electrical prospecting methods, but the reflection seismograph and gravimeter are by far the most widely employed instruments, and more parties have operated in the past year than for some time previously. A direct-current electrical method is in use for taking observations which give the resistivity at increasing depths. An alternating-current method makes use of the fact that the depth of penetration decreases rapidly with increasing frequency. Hence the effect of deep horizons may be eliminated by increasing the frequency, and with fixed electrodes a form of vertical exploration is possible.

There have been great advances in mechanical well logging, and this aids in the interpretation of electrical logs. Neutron logging, gamma-ray logging, mud logging, drilling-time logging, etc., are also being carried out. Caliper logging has proved valuable in several ways.

An electrical method is available for determining the dip of the strata by the use of three electrodes set 120° apart, which give three self-potential curves. Knowledge of the orientation of the electrodes by means of a photoclinometer permits the changes in the three self-potential curves to be employed to give the dip and dip direction of the beds. G. D. H.

Drilling.

285.* **Drilling Fluid Technology. Part 1.** L. C. Uren. *Petrol. Engr*, October 1942, **14** (1), 42.—In rotary drilling, the circulating fluid has a number of important functions to perform. Prompt and continuous removal of the material loosened by the drill prevents accumulation of drill-cuttings and "freezing" of the drill-pipe. Deposition of clay on the walls of the well and within the pores of the wall rocks minimizes the tendency of the walls to cave; lubricates the drill-pipe, reducing frictional power loss; prevents loss of fluid into very porous, low-pressure formations, so that circulation of drill cuttings to the surface will not be interrupted, and seals off high-pressure gas- and water-yielding horizons, so that fluids from them cannot enter the well, thus preventing destructive blowouts. The drilling fluid also prevents destruction of the drilling-bit and drill-pipe by absorbing the heat caused by friction of revolving steel on the bottom and walls of the well. These are matters of prime importance, especially in deep drilling, and failure of the fluid to meet any one of these requirements might prevent successful completion of the well. The paper treats each important function separately.

In raising drill-cuttings from the bottom of the well to the surface, effective action of the drilling fluid depends chiefly on maintenance of a proper fluid density and viscosity, and a rate of flow that will maintain a suitable ascending velocity in the annular space between the drill-pipe and the wall of the well. The size and density of the drill-cuttings are also important factors.

Part 1 further deals with sealing the formations by a clay sheath controlling high-pressure fluids, and with "gas-cut" drilling fluids. Gas-cutting may result in serious blowouts. The fluid must be treated to release the bubbles. This may be accomplished by passing the fluid through a vibrating screen, through a suitably designed trap in which the fluid will be spread out in a thin film over metal surfaces, or by diluting with water, subsequently thickening the fluid to proper density after the gas is released. Addition of chemical reagents to reduce the viscosity of the fluid will also promote release of gas. A. H. N.

286.* **Diesel-Electric Drilling Rig Designed for Simplicity.** J. P. Van Vorst. *Petrol. Engr*, October 1942, **14** (1), 46. The basic idea in designing and building diesel-electric rigs is to make the system as simple and as free from complicated electrical devices as possible. The rig described was designed with this in mind as well as to have the generating units as compact as possible, facilitating transportation and erection. With this arrangement, perfect alignment and levelling are desirable, but not necessary, as the engines and generators are connected as units, and the generators and exciters are not driven by belts, as is the case in some earlier diesel-electric rigs. The rig is described in some detail, the chief component being illustrated and relative data of capacities and dimensions given. A. H. N.

287.* **Methods of Marine Exploitation Differ Throughout the World.** Anon. *Petrol. Engr*, October 1942, **14** (1), 76. Marine exploitation has been practised at many places distributed over the surface of the earth. Among these marine exploitations are the vast Lake Maracaibo operations in Venezuela, the wells drilled in the Gulf of St. George at Comodoro Rivadavia in Argentina, the recovery of oil from below the Irrawaddy River in Burma, the tide-water drilling into the China Sea at the Seria field on the island of Borneo, the developments along the Gulf Coast of Louisiana and Texas, the channel drilling around the Long Beach harbour, and the tide-water operations along the Pacific Coast of California. The methods employed for drilling and producing such areas are obviously governed by conditions, and include the use of barges, the building of piers, and controlled directional drilling from both piers and locations on shore. The paper discusses in separate sections the practices employed on Lake Maracaibo, along the Gulf Coast in Argentina, in Borneo and Burma, and along the Pacific Coast.

Production methods are also discussed. The methods employed in producing oil through individual slant-hole wells from below a body of water and discharging it at a land or pier location are similar to those followed in producing the wells of a land field. Multiple-well locations, however, sometimes require ingenuity to facilitate

their production and servicing, particularly when they are on the pump. The three wells drilled from a pier in the Elwood field, California, for example, are equipped with separate pumping beams, one beam extending in the opposite direction from the other two. Each beam is powered by its own engine, and any one, two, or all wells can be pumped at any time.

Each well of those comprising the groups in the Huntington Beach field mentioned is pumped with its own electric motor-driven unit, the wells having been spaced far enough apart for this purpose. To facilitate servicing the wells, however, tracks were set in a concrete floor laid around each group and a production derrick placed on rollers on these tracks, so that the derrick can be moved to any well needing service, the one derrick thus being used for four or five wells, depending on the number in the group. A. H. N.

288.* Deep-Hole Cable-Tool Drilling Lines. A. S. Rairden. *Petrol. Engr*, October 1942, **14** (1), 138.—The mechanism of breakdown of a cable-tool drilling line is given as follows: As an oil- or gas-well progresses in depth, the accumulated weight of the cable-tool drilling line added to the weight of the stem, jars, tools, etc., will eventually reach a value at which the suspended weight on the drilling-line clamp will be so severe as to cause rapid deterioration of the line. The applied wire-rope load at the clamps eventually becomes so great that extremely severe radial pressures of the outer strands are imposed on the hemp core, resulting in the cutting and pulverizing of the hemp fibres in the core, and also in a severe compression of the hemp core into a more solid mass. All this causes a loss in effective foundation of the hemp core to the outer surrounding strands. A natural result is the distinct lengthening of the rope lay or pitch, which in turn reduces the very necessary elasticity or resilience of the rope, an important quality in a cable-tool drilling line, that enables the rope to absorb easily the shock-loads of the drilling motion. Loss of foundational qualities of the hemp core also causes a reduction of the outer diameter of the wire rope. This diameter reduction finally causes the drilling clamps to grip the rope inadequately, resulting in the line slipping through the liners in the clamps.

The critical loading of the line at the clamps, causing this sequence of deteriorating conditions, are all related and additive, so that when the critical depth and loading are reached in the progress of drilling a well, the complete deterioration of the wire rope at the clamps occurs very rapidly. Usually this deterioration occurs after a well reaches a depth greater than 7500 ft., when the factor of safety on the cable-tool line begins to reach a value equal to 3 or less.

Calculations are given to justify these statements. Whipping of the line may increase the loads by 50% of the deadweight static load. A. H. N.

289. Thermal Characteristics of High-Temperature Oil-Well Cements. E. E. Byrd and F. W. Jessen. *Industr. Engng Chem.*, 1942, **34** (10), 1142.—An investigation has been made on the total heat of hydration and the rate of heat evolution and pumpability for five cements at temperatures of 150°, 175°, and 200° F. In the absence of addition agents, it is shown that the setting times and quantity of heat liberated are a function of the chemical composition and the fineness of the grind. J. W. H.

290.* The Nature of Hastings Drilling Mud by Supercentrifuge and X-Ray Analysis. G. H. Fancher and S. C. Oliphant. *Petrol. Tech.*, November 1942, **5** (6), A.I.M.M.E. Tech. Pub. No. 1531, 1–12.—Two samples of drilling mud were taken from wells in the Hastings field, the muds having been formed from the formations encountered in drilling, and the properties of these muds were examined (viscosity, density, *p*H, filtration rate, total solids, etc.). The size distribution of the solid particles was determined by screening for particles greater than 44 μ in diameter, sedimentation for particles between 1 μ and 44 μ, and by means of the Sharples supercentrifuge for the smallest particles. During the whole series of tests about 12% of the original solids were lost. This total loss was uniformly distributed over the whole size range. The particle sizes calculated from the conditions of separation agreed well with the sizes measured directly with the slit ultramicroscope. 50% of the total solids was made up of particles less than 5 μ in diameter. The size-frequency distribution curves show two peaks, one at about 0·9 μ and the other at 150–200 μ. The mud (Curkeet)

which was taken after the well had penetrated the Oligocene shales showed fewer coarse particles than that (Edwards) taken while the well was still in the sandy Basal Miocene. The lower filtration rate and higher viscosity of the Curkeet mud were in accordance with the presence of more fine particles than in the Edwards mud.

The distribution of minerals in many of the size fractions was determined by X-ray analysis, with an accuracy of 5–10%. This revealed the presence of more silica in the Edwards than in the Curkeet mud. For the Edwards mud the bulk of the fractions less than 0·3 μ average diameter the principal mineral was illite, while in the coarser fractions silica with calcite and felspar were the dominant minerals. These determinations were in agreement with the observed decrease in density of the particles with decrease in particle size. Felspar occurred only among the coarser particles, but silica was distributed over a wide range, and showed two peaks in its frequency curve.

The large amount of illite in the Curkeet mud was no doubt due to the penetration of the Oligocene shale. The calcite may have been derived from thin limestone streaks in the beds, or it may have been precipitated in drilling. The absence of montmorillonite is of interest. Illite is less plastic and swells less than montmorillonite.

Only 7–8% by weight of the mud solids was within the generally accepted range of colloidal dimensions (0·5 μ equivalent diameter or less). Thus the material larger than the colloidal range is quite as important as the colloids in determining the properties of a mud and its susceptibility to chemical treatment. G. D. H.

291.* Calibration and Control of the Supercentrifuge for the Fractionation of Oil-Well Drilling Muds. S. C. Oliphant, C. R. Houssiere, and G. H. Fancher. *Petrol. Tech.*, November 1942, **5** (6), A.I.M.M.E. Tech Pub. No. 1530, 1–7.—The calculation of the size of particles separated by the Sharples supercentrifuge depends on the assumptions: (1) that the flow parallel to the axis of rotation is streamline, and (2) that Stokes' law holds only for dilute suspensions. Continued refractionation with the centrifuge operating under constant conditions results in the deposition of only a very thin film on the liner, and the solid particles are found to be distributed along the bowl in a mono-dispersed film in accordance with a definite equation, the value of the size in relation to the distance along the bowl being unique for given operating conditions.

Charts have been constructed and are given, which permit the selection of operating conditions in order to separate particles between definite size limits, but the charts must be constructed for each centrifuge. They show the rate of feed, rate of rotation, and the air pressure necessary to give the required rate of rotation.

The reliability of the method for determining the size of particles separated by the Sharples supercentrifuge under controlled conditions has been tested by examining fractions with the slit ultramicroscope. The latter device has various sources of error, but on the whole it was deemed that the indications were such as to confirm the reliability of the sizing carried out in the supercentrifuge. G. D. H.

292. Patents on Drilling. H. J. Woolslayer, E. A. Campbell, and C. J. Jenkins U.S.P. 2,300,480, 3.11.42. Appl. 11.8.41. Folding derrick base for portable oil-well derricks.

J. W. O'Brien. U.S.P. 2,300,590, 3.11.42. Appl. 4.6.41. Conditioning of drilling mud to increase its specific gravity and maintain the viscosity within a normal range by adding celestite and a viscosity reducing chemical.

C. R. Atky. U.S.P. 2,300,763, 3.11.42. Appl. 28.10.41. Portable well derrick with telescopic mast.

T. W. Pew. U.S.P. 2,300,805, 3.11.42. Appl. 13.1.41. Drilling bit.

A. D. Whitman U.S.P. 2,300,823, 3.11.42. Appl. 18.12.39. Indicating device for well-drills.

P. A. Wolff. U.S.P. 2,301,001, 3.11.42. Appl. 14.11.40. Well superstructure (apparently to take the stresses on a depth-measuring wheel).

L. Yost. U.S.P. 2,301,105, 3.11.42. Appl. 1.5.41. Safety collar for drills in a turbine-driven well-drilling unit.

T. E. McMahan. U.S.P. 2,301,307, 10.11.42. Appl. 14.1.42. Means for orientating tools in bore-holes.

C. E. Reistle, Jr. U.S.P. 2,301,326, 10.11.42. Appl. 3.11.39. Process for obtaining temperature gradients in bore-holes.

H. J. Craig, H. C. Brown, and D. Ragland. U.S.P. 2,301,377, 10.11.42. Appl. 29.9.41. Rotary releasing socket.

R. F. Farris. U.S.P. 2,301,389, 10.11.42. Appl. 22.8.40. Apparatus for cementing wells consisting of spring-bars which shear the cement in its flow in the casing but allow the plugs to pass through.

H. Salvatori. U.S.P. 2,301,458, 10.11.42. Appl. 31.10.40. Seismic well-logging.

W. A. Abegg. U.S.P. 2,301,495, 10.11.42. Appl. 8.4.39. Method and means of renewing the shoulders of tool-joints.

G. A. Smith. U.S.P. 2,301,757, 10.11.42. Appl. 27.3.41. Well-surveying instrument with an electrically operated recorder.

J. Neufeld. U.S.P. 2,302,247, 17.11.42. Appl. 22.4.40. Well-surveying method and apparatus using radioactivity.

C. A. Peufield. U.S.P. 2,302,249, 17.11.42. Appl. 26.3.40. Pipe spinner in combination with a pipe-tongs.

G. L. Kothney. U.S.P. 2,302,330, 17.11.42. Appl. 6.3.42. Apparatus for orientating tools and removal of whipstocks.

L. K. Heiner. U.S.P. 2,302,692, 24.11.42. Appl. 14.7.41. Well-drilling pump unit.

W. H. Hamon. U.S.P. 2,302,856, 24.11.42. Appl. 10.8.40. Releasable joint for rotary well strings.

J. M. Lilligren. U.S.P. 2,302,996, 24.11.42. Appl. 12.10.38. Sampler for well drillings from the stream.

W. H. Martin. U.S.P. 2,302,998, 24.11.42. Appl. 14.10.40. Pipe-tongs.

G. C. Maddox. U.S.P. 2,303,085, 24.11.42. Appl. 20.3.40. Device for removing samples from fluid streams adapted for well-drilling muds.

A. Pranger and S. A. Guilerson. U.S.P. 2,303,090, 24.11.42. Appl. 8.11.38. Pressure drilling head with packer element.

R. R. Schweitzer. U.S.P. 2,303,178, 24.11.42. Appl. 24.2.41. Well-drilling apparatus with rotary drill-pipe.

W. F. Sheffield. U.S.P. 2,303,312, 24.11.42. Appl. 11.4.41. Well pipe-jack.

A. H. N.

Production.

293.* Progress in Reservoir Technology. Part 3. M. Muskat. *Petrol. Engr*, October 1942, **14** (1) 35–36.—This part of the paper deals with secondary recovery methods. It is explained that by simple gas cycling no more oil would be produced than that yielded by primary production were they continued into the high gas-oil ratios and uneconomically low rates. In contrast to the simple secondary recovery method of gas cycling, the injection of gas into a gas-cap for the purpose of pressure maintenance is based on sound technical principles. Here the segregation of the gas above the main oil-pay permits the former to exert a driving action on the oil, rather than a sweep or drag, as obtains in the simple gas-cycling method. Because of the higher oil saturations in the sand surrounding the producing wells, the permeability to the

oil is maintained and at the same time the growth in gas permeability is retarded. Hence if the regional pressure gradients within the oil-pay near the gas-oil interface can be held below those corresponding to the gravity differential between the gas and oil, bypassing and channelling of the gas through the oil-saturated section can be prevented.

From the physical point of view the secondary recovery method of water-flooding is well founded and inherently efficient. As previously indicated, the residual oil saturation in a sand that has been traversed by a water-flood is very materially lower than that remaining in a sand subjected to a gas-drive, even when the latter is continued to high gas–oil ratio conditions. When the residual oil saturation at the close of the primary production phase is sufficiently high, and the producing zone is not lenticular, and is of reasonable uniformity in permeability, water-flooding offers promise for materially increased oil recovery. These are the primary criteria for success, and such factors as well-spacing and flooding pattern do not appreciably affect the physical efficiency of the operations. The latter are of real significance only in determining the economics of the problem. It is pointed out, however, that in certain cases controlled production under a water-drive may be more advantageous than rapid production followed by water-flooding.

Condensate reservoirs and retrograde phenomena are discussed and the necessity of maintaining the pressure made evident. Gas cycling for this purpose is the simple solution. Although the development of this method was based largely on the idea that the single-phase bearing formation constituted the whole of the so-called condensate reservoir, this restriction is necessary neither from a theoretical nor a practical viewpoint. On the contrary, in order for the single-phase fluid to undergo condensation on a drop in pressure, it must be at its dewpoint—*i.e.*, saturated with the heavier and condensable liquid hydrocarbons. This means that it must have been at some time in equilibrium with a liquid phase having a composition the same as that which drops out as soon as the pressure is lowered. In the light of generally accepted views on the origin and accumulation of oil, it seems highly probable that at the time of discovery, the single-phase fluid is still in equilibrium with a heavy liquid phase. A. H. N.

294.* Treating Plant for Heavy Oil Production. W. A. Sawdon. *Petrol. Engr*, October 1942, **14** (1), 25–26.—The oil being treated comes from a field in California. The oil from this area ranges in gravity from 8 to 17·5° A.P.I., with the wet oil averaging 15° A.P.I. This oil has a high viscosity even for its gravity, and the measured viscosity of some of the wet oil has been as high as 200,000 seconds Saybolt at 80° F. The viscosity of the wet oil being treated ranges from 20,000 to 30,000 seconds Saybolt at 100° F.

The treating plant at present consists essentially of eight electric dehydration units, four heaters, two pumps, and necessary tankage and piping. It is illustrated by a diagram. It is entirely automatic in operation. The net quantity of oil being taken from the dehydrators is approximately 10,000 brls. daily. When expanded, the plant will have twelve units with a gross capacity of 22,000 brls. daily. Only the wet oil from the field passes through the plant. The average cut of this oil is 32%, and the gas is taken off by low-pressure separators in the field. The vapour pressure is 25 lb. at 190° F. The dry oil from the dehydrators averages 1·5% cut.

The electric dehydrators are completely automatic. They operate on a current of 28,000 volts, and the installation includes double transformer hook-ups. The shell of each unit is 10 ft. in diameter, and provides for 36 lb./sq. in. working pressure. It is important in this plant to keep the pressure relatively high, to prevent any gas leaving the oil during dehydration, and a working pressure of 34 lb./sq. in. should be maintained at all times. The shells are insulated, because the density or gravity of the oil is very close to that of water, and it is important to keep the heat constant. This temperature control keeps conditions in the unit constant, permitting complete separation to take place, which might not be the case with fluctuating temperatures.

The dehydrating units are equipped with multiple-field, concentric-ring electrodes, and have a wide lower field with low gradient voltage across it. The dry oil is removed continuously from the top of the units, and the separated water is drawn off intermittently by means of automatic electrically controlled valves.

Recirculation is practised. A. H. N.

295.* Surface Energy Relationships in Petroleum Reservoirs. H. K. Livingston. *Petrol. Tech.*, November 1942, **5** (6), A.I.M.M.E. Tech. Pub. No. 1526, 1–6.—A technique has been developed which makes it possible to determine the spreading pressure of liquids on solids for simple systems. Data on the surface tensions, interfacial tensions, spreading pressures, and contact angles for water, heptane, and silica are tabulated. These data can be applied in evaluating the capillary rise and displacement pressure in a petroleum reservoir. Equations are given for calculating the capillary rise and displacement pressure, and their application is discussed.

The presence of surface-active substances affects both capillary rise and displacement pressure, and also seems to influence the rate of fluid flow. G. D. H.

296.* Reservoir Analysis and Geologic Structure. J. M. Bugbee. *Petrol. Tech.*, November **5** (6), A.I.M.M.E. Tech. Pub. No. 1527, 1–12.—An effective water-drive appears to be the most desirable reservoir production mechanism. Water-drive may result either from the expansion of edge-water or from the artesian flow of edge-water extending to the outcrop. Thus the extent of the reservoir has an important bearing on both the rate and ultimate quantity of water influx into an oil-pool.

Lens-type reservoirs are generally recognized, and in such reservoirs only the expansion water-drive can operate, but the complete structure of the more important domal types, in which possible crestal and synclinal faulting may limit the effective extent of the reservoir, is not well understood. The delineation of the structure of the domal types is becoming increasingly more accurate due to the introduction of coring, electrical logging, etc., although the absence of drilling in the synclinal areas prevents such complete delineation of the faults in these areas.

Inferences drawn from cores and electrical logs, coupled with scattered well data and geophysical data for the synclines, and a consideration of the dynamics of folding and faulting, may be applied to determine the complete picture of the geological structure. Since faulting on the domes and in the synclines may effectively seal, and thus limit, the size of a reservoir, thereby barring additional water influx, the consideration of the geological structure and its possible effects is essential to a complete analysis and prediction of reservoir performance. G. D. H.

297.* Effect of Casing Perforations on Well Productivity. M. Muskat, *Petrol. Tech.*, November 1942, **5** (6), A.I.M.M.E. Tech. Pub. No. 1528, 1–10.—Analytical calculations have been carried out on the effect of casing perforations on the productivity of wells, and formulæ have been derived for general types of perforation patterns. Numerical calculations show that the resultant well productivity is essentially independent of the perforation pattern, but is determined mainly by the total perforation density. Thus a density of three perforations per foot of casing reduces the well productivity to one-third of that of the uncased well for a perforation radius of $\frac{1}{2}$ inch, and to approximately one-half for a perforation radius of $\frac{1}{4}$ inch, regardless of the detailed manner in which the perforations are distributed over the casing surface. The reduction is slightly greater for 6-inch-radius casing than for 3-inch-radius casing.

The analytical theory is also extended to include wells completed with slotted liners. The reduction in productivity due to such liners is relatively small compared with that due to perforated casing.

While it is felt that the calculations indicate the correct magnitude of the effect of casing perforations on well productivity, it is not to be assumed that the predicted effects will necessarily be observed in field practice. The actual productivity of a well is the resultant of a great many factors, only one of which is the type of casing perforations, if any. Variations in these other factors—sand permeability, fluid saturation distribution, gas–oil ratio, cleanliness of sand face, etc.—may well counterbalance and mask completely the limited effect of the casing perforations in making comparisons between cased and open-hole completions, even in the same field. The calculations are based on idealized assumptions, and have no greater validity than these assumptions. The analysis was carried through for a homogeneous fluid system. G. D. H.

298.* Analysis of Reservoir Performance. R. E. Old. *Petrol. Tech.*, November 1942, **5** (6), A.I.M.M.E. Tech. Pub. No. 1529, 1–13.—Quantitative methods are available for

the identification and determination of the magnitude of water encroachment, for the estimation of the original oil in place, and for the calculation of the pressure behaviour in oil reservoirs. These methods have been applied in a study of the Jones sand of the Schuler field. The initial oil content of the reservoir was estimated in two ways, the results agreeing closely, and with two years of pressure-production records as a background, the pressure behaviour for the following three years was calculated and compared with the actual measurements, satisfactory agreement being obtained.

It is clear from this and similar studies that the use of the material balance and water-drive equations, when properly applied to field data, gives a fundamental tool for the evaluation of reservoir performance. In particular, the pressure behaviour may be predicted. Critical rates of production may be established for water-drive fields, and rates and quantities of injected water to supplement natural encroachment may be pre-determined. The effect of gas injection can be predicted before the injection is undertaken. Consequently, the effects of various production programmes can be safely evaluated beforehand, and when these determinations are combined with core-analysis saturation data, the economics of recovery under each can be analyzed, and the most profitable programme selected.

The calculations can be made when reservoir pressure measurements, production records of oil, water and gas, and bottom-hole sample analyses are known. The determination of the structural dimensions, using porosity, connate water content, and permeable thickness from core analyses, will aid in earlier application and increased accuracy of the results.

Complete and accurate pressure and production records are essential. The reservoir pressure is affected as much by the withdrawal of equal volumes of water and gas as by oil, so that the extra effort of measuring and recording these quantities is well justified in view of the increased knowledge of reservoir performance that may be gained by their use. G. D. H.

299. Patents on Production. G. W. Ayers, Jr. U.S.P. 2,300,393, 3.11.42. Appl. 29.5.40. Method of increasing fluid permeability of earth or rock formations which are siliceous in nature.

F. J. Spang. U.S.P. 2,300,438, 3.11.42. Appl. 10.2.40. Well-packer with expansible element and slips.

M. De Groote and B. Keiser. U.S.P. 2,300,554, 3.11.42. Appl. 12.5.41. Process for breaking petroleum emulsions of the water-in-oil type by means of a demulsifier.

M. De Groote and B. Keiser. U.S.P. 2,300,555, 3.11.42. Appl. 12.5.41. Process for breaking petroleum emulsions of the water-in-oil type by means of a demulsifier.

F. E. Carlberg. U.S.P. 2,300,648, 3.11.42. Appl. 13.7.42. Well-pump of the sucker-rod reciprocating type.

G. A. Smith. U.S.P. 2,300,709, 3.11.42. Appl. 10.1.41. Electrical prospecting method to determine the porosity characteristic of strata traversed by a well.

H. Allen and M. T. Works. U.S.P. 2,300,854, 3.11.42. Appl. 24.6.40. Tubing bottom with a back-pressure valve.

A. Boynton. U.S.P. 2,301,190, 10.11.42. Appl. 4.10.38. Well-testing tool of the pump-packer type.

A. Boynton. U.S.P. 2,301,191, 10.11.42. Appl. 28.10.38. Well-testing tool, rat-hole type.

C. M. Peters. U.S.P. 2,301,319, 10.11.42. Appl. 15.11.41. Plunger for use in cylinders of deep-well pumps.

A. F. Spengler. U.S.P. 2,301,340, 10.11.42. Appl. 27.12.38. Motor or the like for actuating a well-pump unit.

A. L. Armentrout. U.S.P. 2,301,355, 10.11.42. Appl. 9.4.40. Flow-bean.

G. L. Adams and A. Shapiro. U.S.P. 2,301,494, 10.11.42. Appl. 11.3.41. Treatment of oil-wells to prevent emulsification.

C. F. Bonnet, U.S.P. 2,301,609, 10.11.42. Appl. 30.1.41. Breaking petroleum emulsions of the water-in-oil type by means of a demulsifier.

C. K. Holt. U.S.P. 2,301,624, 10.11.42. Appl. 19.8.40. Tool for use in wells to place fluids therein.

H. H. Holmes. U.S.P. 2,301,875, 10.11.42. Appl. 25.1.40. Method of treating oil-wells in calcareous formations.

J. D. Nixon. U.S.P. 2,302,391, 17.11.42. Appl. 22.10.40. System and apparatus for lifting fluid from wells.

F. E. O'Neill. U.S.P. 2,302,567, 17.11.42. Appl. 13.12.37. Method and means of perforating well-casing and the like by means of a stream of fluid carrying abrasive solids.

T. L. Jarvis. U.S.P. 2,302,774, 24.11.42. Appl. 27.3.42. Electric heater for oil-wells.

J. N. Downs. U.S.P. 2,302,905, 24.11.42. Appl. 24.5.40. Well-packer.

C. J. O'Donnell. U.S.P. 2,303,134, 24.11.42. Appl. 17.2.41. Means for packing wells with a prepacked liner. A. H. N.

Gas.

300.* Corrosion of Metals and Alloys by Flue Gases. L. Shnidman and J. S. Yeaw. *Industr. Engng Chem.*, 1942, **34** (12), 1436.—The corrosion behaviour of metals and alloys when exposed to flue gases has been examined. The fuels used for this examination included two natural gases. The effect of sulphur is given on the amount of corrosion experienced under various conditons of flue-gas temperature. From the data obtained, the maximum life of 22 different sheet metals of 20 gauge thickness has been estimated. J. W. H.

Cracking.

301. Patents on Cracking. Standard Oil Development Co. E.P. 548,760, 23.10.42. Appl. 2.12.40. The cracking characteristics of hydrocarbon oils are improved by pretreatment which involves selectively removing substantially only hydrocarbons of high specific dispersion. These are in fact the condensed ring aromatic constituents of the oil.

P. K. Frolich. U.S.P. 2,303,076, 21.11.42. Appl. 18.5.38. Improvement in the method of catalytic cracking of hydrocarbon oils which involves a bank of catalytic converters containing a mass of cracking catalyst which is subjected to periodic regeneration *in situ* to remove carbonaceous deposits, and wherein the cracking and regeneration periods in the individual converters are arranged in staggered relationship one to another. The improvement lies in initially passing the oil to be cracked through the converter in the later stages of the cracking period, and afterwards passing all vapour products from this converter to a converter in the earlier stages of the cracking period. In this way the oil is contacted with partly spent catalyst and afterwards with a catalyst which has been subjected to cracking treatment for a substantially shorter period.

W. L. Benedict. U.S.P. 2,304,070, 8.12.42. Appl. 25.11.40. A conversion process in which a hydrocarbon oil is thermally cracked, and the resultant products are fractionated. The reflux condensate therefrom is then subjected to catalytic cracking in contact with a first catalyst bed. Simultaneously a second catalyst bed previously used in processing, is subjected to exothermic regeneration. Insufficiently converted hydrocarbons are separated from the catalytically cracked products, and at least part of them are passed in indirect heat exchange relation with the first and second catalyst beds. Subsequently they are passed to the thermal cracking process.

R. F. Ruthruff. U.S.P. 2,304,083, 8.12.42. Appl. 28.2.40. Relatively low-boiling olefinic hydrocarbons are contacted at a high temperature with a catalyst having as an essential ingredient cobalt pyrophosphate. In this way the low-boiling olefinic hydrocarbons are converted to hydrocarbons boiling within the gasoline range.

E. H. McGrew. U.S.P. 2,304,189, 8.12.42. Appl. 30.9.39. In a conversion process, hydrocarbon oil is subjected to thermal cracking, and from the resultant products a reflux condensate heavier than gasoline, a gasoline distillate, and a normally gaseous fraction containing polymerizable olefins are separated. The last fraction is subjected to polymerization and a polymer fraction is separated which boils substantially within the gasoline range. This polymer fraction is then subjected to the action of a cracking catalyst at a temperature between 500° and 900° F. under conditions designed to effect substantial saturation of the polymers by the transference of hydrogen thereto from the reflux condensate.

C. O. Tongberg. U.S.P. 2,304,289, 8.12.42. Appl. 2.12.39. In a process for cracking hydrocarbon oils, the oil is first treated with a selective solvent capable of removing aromatic constituents. The treatment is controlled in such a way that a solvent extract phase is obtained which consists principally of condensed ring aromatics having a specific dispersion above 190. The raffinate phase is substantially free of condensed ring aromatics but contains substantial amounts of single-ring aromatics. After separation the raffinate phase is subjected to cracking treatment to produce lower boiling hydrocarbons. H. B. M.

Hydrogenation.

302. Patent on Hydrogenation. F. E. Frey. U.S.P. 2,303,118, 24.11.42. Appl. 12.10.39. Process of catalytic non-destructive hydrogenation of relatively volatile normally liquid olefin hydrocarbons boiling in the motor-fuel range. The liquid hydrocarbons, together with recycled hydrogenated hydrocarbons and hydrogen, are fed into the upper part of a vertical hydrogenator containing a supported hydrogenation catalyst. The process is operated without substantial removal of heat by a cooling medium in indirect heat exchange relationship with hydrogenator. Temperature and pressure are so controlled that a substantial amount of the hydrocarbon material at the top of the hydrogenator is in liquid phase, and that there is a progressive increase in temperature from top to bottom of the hydrogenator. Hydrogenated and vaporized hydrocarbons are withdrawn from the lower part of the hydrogenator, and afterwards these are separated from unused hydrogen by condensation. H. B. M.

Polymerization and Alkylation.

303. Patents on Polymerization and Alkylation. Standard Oil Development Co. E.P. 548,525, 14.10.42. Appl. 14.2.41. In the catalytic reforming of hydrocarbon oils boiling within the gasoline boiling range in the presence of a gas rich in free hydrogen, gaseous products of reaction are continuously recycled to provide the gas. The improvement claimed lies in heating the oil and gas or recycled gaseous products in separate heating zones prior to their introduction into the reaction zone. The entire stream of products leaving the reaction zone is passed to a fractionation process without any indirect cooling.

Dorman, Long & Co., Ltd. E.P. 549,516, 25.11.42. Appl. 31.3.41. Process for the refining of solvent naphtha for the production of xylene therefrom. The naphtha is first washed with caustic alkali to remove materials such as phenols, which would inhibit thermal polymerization of the unsaturateds. Afterwards, the washed material is submitted to fractional distillation in a still fitted with a fractionating column and condenser, with consequent thermal polymerization of the unsaturateds and their retention in the still as the xylene fraction distils over.

R. Pyzel and E. R. Kanhofer. U.S.P. 2,304,654, 8.12.42. Appl. 19.10.39. After subjecting normally gaseous hydrocarbons to polymerization, all of the products

except gases boiling below propane, are absorbed in a polymer liquid consisting of materials boiling within the gasoline range. The resultant enriched polymer liquid is stabilized to separate from it a fraction consisting essentially of three-carbon atom gases and a fraction consisting essentially of four-carbon atom gases. Regulated quantities of the former fraction are returned to the polymerization process and part of the stabilized polymer liquid is passed to the absorption process as absorber oil.

H. B. M.

Synthetic Products.

304. Petroleum Resins. Anon. *Chem. Tr. J.*, 29.1.43, **112**, 102.—Reactive distillates from the cracking of, *e.g.*, propane or butane at high temperature and pressure form a useful source of petroleum resins. When treated with aluminium chloride, condensation and polymerization takes place to a hard, amber-coloured resin, melting at about 100° C. It is still quite unsaturated and reactive, and oxidizes readily when exposed in a thin film, accelerating the gelation of tung and other varnish oils. It can be combined with drying or semi-drying oils for special purposes, or used directly in a varnish kettle for producing quick-drying varnishes. Many types of resins are produced from distillates differing in chemical composition or by the use of different catalysts. While the main outlet is in the paint industry, they are also used in the production of printing ink, plastic tile, linoleum, laminates, and impregnated fibres.

C. L. G.

Refining and Refinery Plant.

305.* Condensation of Vapours from Non-condensing Gases. J. C. Smith. *Industr. Engng Chem.*, 1942, **34** (10), 1248.—The previous method for the design of condensers to handle vapours in non-condensing gases, proposed by Colburn and Hougen, neglects part of the heat loss from the condensate layer in calculating the temperature gradient along the condenser. Data obtained on actual condensers showed that a higher rate of heat transfer was obtained than that predicted by the theory in the case of organic liquids of low latent heat. The new theory proposed makes full allowance for the cooling of the condensate, and an actual example worked out by both methods shows that the new method gives a surface area which is 14% less than that calculated from the old.

J. W. H.

306.* Liquid Capacity of Bubble-Cap Plates. A. J. Good, M. H. Hutchinson, and W. C. Rousseau. *Industr. Engng Chem.*, 1942, **34** (12), 1445.—In large-diameter bubble-plates, or moderate-diameter plates operating at high liquid loads, the hydraulic gradient set up across the plate becomes an important factor in determining the maximum liquid load which can be handled by the plate. Previously it has been customary to express this load in terms of the rate of liquid flow per unit cross-sectional area of plate. This is not a satisfactory method of expressing this factor, and it is better considered as the rate of liquid flow per unit mean width of plate. From the results of data obtained on an experimental bubble-plate graphs are given which enable the effect of the variables in bubble-cap design on the liquid loading of the plate and the pressure drop to be estimated. The use of these data is illustrated by the solution of an actual problem.

J. W. H.

307. Patents on Refining and Refinery Plant. Houdry Process Corp. E.P. 549,547, 26.11.42. Appl. 10.2.41. The patent embodies a two-stage process for the refining of naphthas and like hydrocarbon stocks of gasoline boiling range, carried out in the presence of catalysts. Total products from the first stage are passed to the second stage. In the first stage the naphtha is subjected to a splitting reaction in the presence of silica–alumina catalysts. The second-stage products of this reaction are immediately subjected to a dehydrogenation reaction in the presence of metallic catalysts.

Standard Oil Development Co. E.P. 549,699, 3.12.42. Appl. 6.8.40. The water content of hydrocarbon fluids is reduced by treating with an inorganic dehydrating agent. The fluid is first treated at a relatively high temperature with the dehydrating agent in a relatively high degree of hydration. In this way part of the water is

removed. The partly dried fluid is then treated with the dehydrating agent at one or more successively lower degrees of hydration, and at successively lower temperatures. The final stage is carried out with the dehydrating agent in a form having a dissociation pressure lower than the partial vapour pressure exerted by the desired final water content in the fluid at the temperature of operation.

F. M. Watkins. U.S.P. 2,302,281, 17.11.42. Appl. 18.5.39. Method of refining a petroleum oil containing a small proportion of organic nitriles formed *in situ* in the oil by conversion of the organic acids and esters to nitriles. The oil is subjected to the action of substantially anhydrous ammonia at a temperature below that at which substantial cracking of the oil occurs.

R. W. Henry and J. V. Montgomery. U.S.P. 2,302,319, 17.11.42. Appl. 11.9.39. Method of refining and purifying mineral oil to separate the asphaltic and other undesirable bodies from the paraffinic portion of the oil. Commercial pyridine is added to the oil as the selective solvent in an extraction zone. A constant-boiling-point mixture of water and pyridine is added to the solution in the extraction zone as a precipitant to cause a refluxing action. In this way are obtained a raffinate phase and an extract phase. The extract phase is withdrawn and fractionated to obtain a constant-boiling-point mixture of water and pyridine, and it is afterwards returned to the extraction zone for further refluxing.

H. G. Schutze. U.S.P. 2,302,352, 17.11.42. Appl. 4.8.40. Petroleum oil which has been sweetened with a copper-containing reagent can be stabilized by treatment with anthranilic acid. In this way an insoluble complex copper-containing compound is precipitated from retained copper salts reacted with the anthranilic acid.

E. M. Dons and O. G. Mauro. U.S.P. 2,302,429, 17.11.42. Appl. 15.6.40. During the separation of petroleum oils and waxes, both oil and wax are dissolved in a solvent comprising over 25% *iso*propyl acetate and less than 75% methylene dichloride. The solution is cooled to a temperaure at which the *iso*propyl acetate and the methylene dichloride will selectively dissolve the oil and reject the wax. The selected oil solution is afterwards separated from the rejected wax.

E. M. Dons and O. G. Mauro. U.S.P. 2,302,657, 17.11.42. Appl. 26.12.41. During the process of dewaxing oils and de-oiling the wax, a settling zone is maintained in communication with a counterflow de-oiling zone. While the oil is being dewaxed in the settling zone, wax is being de-oiled in the counterflow zone.

E. M. Skinner. U.S.P. 2,302,916, 24.11.42. Appl. 26.7.40. Salt is removed from crude petroleum by heating the oil to a temperature sufficient to remove substantially the water associated with the salt and reducing the salt to a dispersed solid.

A. P. Giraitis. U.S.P. 2,303,077, 24.11.42. Appl. 6.2.40. Method of refining white oils which involves exhaustively treating a petroleum oil with concentrated sulphuric acid, separating the sludge, neutralizing the oil with an alkaline solution, washing the oil to remove sulphonate soaps, and finally chemically stabilizing the oil by treating with an essentially dry, alkaline-earth basic compound.

W. T. Hancock. U.S.P. 2,303,547, 1.12.42. Appl. 18.6.40. Petroleum hydrocarbons are refined by a process which includes passing a stream of such hydrocarbons through a cracking zone; subsequently passing the vapours from this zone to a conversion zone containing a foraminate body of material so as to subject the hydrocarbons to cracking and polymerization. The vapours are then introduced into a body of condensate maintained within the lower interior of the conversion zone. Thus mixed liquid and vapour fractions are subjected to intimate contact with this material by upward displacement of the condensate, and the liquid fractions constantly wash the material in the presence of hydrocarbons undergoing cracking, and polymerization vapours are removed from the conversion zone, and the condensate and its contained polymers are afterwards separately removed.

S. C. Carney. U.S.P. 2,303,609, 1.12.42. Appl. 10.6.40. Method of stabilizing crude oils which involves passing the oil through a series of desorbing zones of successively lower pressures to remove the methane. The methane gas which is separated

in each succeeding desorber is compressed and injected without cooling into the preceding desorber. The partly demethanized crude oil from each desorber is cooled prior to pressure reduction and injection into the respective succeeding desorber. The demethanized crude oil is passed through a rectification process to remove an overhead fraction consisting of polymerization feed-stock and natural gasoline. This fraction is then condensed to produce liquid polymerization feed-stock and natural gasoline. By removal of the condensed fracton the crude oil is stabilized.

D. G. Brandt. U.S.P. 2,303,721, 1.12.42. Appl. 9.5.33. Method of separating wax or petrolatum from mineral-oil lubricants. The original oil is mixed with a low-boiling hydrocarbon at a temperature of approximately 100° F., and then slowly cooled to a temperature between 25° and 45° F. Afterwards it is rapidly chilled to about − 40° F. by vaporizing a portion of the low-boiling-point hydrocarbon. Finally precipitated wax is separated from the chilled mixture.

R. L. Gholson. U.S.P. 2,303,835, 1.12.42. Appl. 9.5.39. Sour petroleum distillates are sweetened in the following manner. A catalyst is provided, consisting of ferric sulphate salt and sodium chloride in equilibrium solution with air. An absorbent body of granular character is saturated with the catalyst, and the whole subjected to a temperature of 140° F. After moisture has been removed from the absorbent mass, the distillates under treatment are passed through it. H. B. M.

Chemistry and Physics of Hydrocarbons.

308. Vapor-Pressure Chart for Volatile Hydrocarbons. R. V. Smith. *U.S. Bur. Mines Information Circular*, No. 7215, August 1942.—During investigations of the physical properties of petroleums and natural gases in the Laboratories of the Bureau of Mines at Bartlesville, the author of this report had to make frequent reference to published data on the vapour pressures of volatile hydrocarbons. It was found that such data were widely scattered throughout the literature, and also that they frequently referred to uncommon units of pressure and temperature. Subsequently an endeavour was made to collate such data and to refer them to commonly used units of pressure and temperature.

The chart reproduced in this report was constructed by plotting collected data on semi-logarithmic co-ordinate paper on which the ordinate is the logarithm of vapour pressure and the abscissæ is the reciprocal of degrees Kelvin (degrees centigrade absolute). To facilitate use of the chart in low-temperature distillation analyses, a millivolt scale is provided for users of 3-element copper constantan thermocouples.

Pressure and temperature ranges covered by the chart provide space for plotting the vapour pressures of all hydrocarbons up to *n*-dodecane with the exception of pressures for methane below 15 millimetres of mercury. Vapour-pressure data are incomplete for *iso*pentane below pressures of 50 millimetres of mercury. Available critical constants for neopentane at the time of construction of the chart were apparently in error, as two lines were obtained with slightly different slopes. Data for *iso*butane are inconsistent in trend between pressures of 300 and 760 millimetres of mercury. H. B. M.

309.* The Halogenation of Aliphatic Hydrocarbons. G. Egloff and M. Alexander. *Oil Gas J.*, Part I, 20.8.42, **41** (15), 41; Part II, 27.8.42, **41** (16), 39; Part III, 3.9.42, **41** (17), 34.—This is a series of three articles discussing the halogenation of straight-chain hydrocarbons which commonly occur in petroleum or are produced during the processing of petroleum and its fractions by modern refinery methods. A digest of the methods employed and results obtained by research workers is given under the headings mentioned below, and appropriate literature references are provided. Theories of the mechanism of the reactions involved as advanced by various workers are given, and are critically reviewed.

Part I deals with the halogenation of the alkanes under four main headings covering the methods employed, which are (1) thermal, (2) catalytic, (3) photochemical, (4) indirect by reaction of alkyl halides with suitable inorganic halogen derivatives. The fourth method is normally employed for the preparation of fluorine derivatives.

Part II deals with the preparation of halogen substitution and addition products from alkenes by reaction with the halogens, and also the formation of addition products by reaction with hydrogen halides. Effects of reaction temperatures, catalysts, solvents, etc., are discussed.

Part III covers the following preparations: (1) Alkene addition compounds through the medium of halogenated reagents other than halogens and hydrogen halides. (2) Alkene addition compounds formed by reaction of alkenes with halogens and hydrogen halides in the presence of catalysts such as certain metals, metallic salts, and organic compounds. (3) Addition compounds formed by reaction by alkenes with halogens and hydrogen halides by photochemical methods. (4) Alkadiene addition compounds formed by reaction of alkadienes with halogens and hydrogen halides. (5) Substitution and addition compounds formed by reaction by alkenynes with halogens and halogenated reagents. R. A. E.

310.* **The Nitration of Aliphatic Hydrocarbons.** G. Egloff, M. Alexander, and P. Van Arsdell. *Oil Gas J.*, Part I, 15.10.42, **41** (23), 39; Part II, 22.10.42, **41** (24), 49.—Nitroparaffins were first prepared some 70 years ago, but it was not until 1940 that production on a commercial scale was commenced in the U.S. Physical properties of the lower members of the series produced commercially are tabulated. Nitroparaffins are valuable materials for use as solvents for a wide variety of purposes and as raw materials for preparation of explosives, lachrymators, amines, etc.

A commercial process for producing nitroparaffins consists of: (1) high-temperature nitration of propane in vapour phase, (2) separation of reaction products and recovery of unreacted materials for recycling, (3) fractional distillation and purification of the nitroparaffins. In addition to 1- and 2-nitropropane, nitro-methane and nitro-ethane are produced by this method.

The alkanes are the most difficult aliphatics to nitrate, especially the lower members of the series, for which vapour-phase nitration was found to be the solution. The four general methods of nitration are: (1) vapour-phase nitration with nitric acid, by which method mononitro-compounds can be produced practically to the exclusion of dinitro- and more highly nitrated compounds; (2) vapour-phase nitration with nitrogen tetroxide, which yields both mono- and dinitro-compounds; (3) liquid-phase nitration with nitric acid and nitric-sulphuric acid mixture, applicable to alkanes of 5 or more carbon atoms. Increased concentration of acid increases both oxidation and nitration and produces relatively greater amounts of di- and poly-nitro-derivatives; (4) catalytic. Certain nitrates have been found useful catalysts in processes already mentioned, and promote reaction of alkanes with nitric oxide at high temperatures.

Part II deals with the nitration of alkenes and alkynes. Nitration of the alkenes may be accomplished by (*a*) nitric acid, (*b*) nitrogen oxides, (*c*) catalytic methods, (*d*) electrochemical methods. R. A. E.

311.* **Phase Equilibria at High Temperatures.** R. R. White and G. G. Brown. *Industr. Engng Chem.*, 1942, **34** (10), 1162.—A complete description is given of an apparatus for determining the liquid-vapour phase equilibrium at temperatures up to 820° F. and at pressures up to 700 p.s.i. Essentially this apparatus consists of a pipestill preheater and a flash-pot which embodies a Hagen separator, to ensure that no liquid is carried over with the vapour, and a liquid level controller to ensure that no vapour is passed out with the equilibrium residue. This liquid level controller is of special design, and depends on the change in capacitance between the liquid and vapour phases. This liquid level indicator will operate satisfactorily to a reduced pressure condition of 0·95 at the critical temperature. Using this apparatus, liquid-vapour equilibria have been investigated for petroleum fractions boiling between 95° and 750° F. up to the pressures and temperatures given above. From the data obtained the vaporization constants have been calculated, and these constants include values in the critical and retrograde condensation regions for complex hydrocarbon mixtures. J. W. H.

312.* **Nomograph for Calculating Reduced Temperature.** D. S. Davis. *Industr. Engng Chem.*, 1942, **34** (10), 1174.—A nomogram is given which enables the reduced temperature to be rapidly estimated. The critical temperature scale is also marked with a number of common hydrocarbons. J. W. H.

313.* Nomographs for Mean Driving Forces in Diffusional Problems. E. C. Scheibel and D. F. Othmer. *Industr. Engng Chem.*, 1942, **34** (10), 1200.—The construction and use of nomograms are given which enable the mean driving force in diffusional problems to be rapidly estimated. These nomograms greatly facilitate the use of the equations given by the authors for the solution of diffusional problems in *Trans. Amer. Inst. Chem. Engrs*, 1942, **38**, 339. The use of the nomograms is illustrated by examples of absorption, distillation, and extraction problems. J. W. H.

314.* Composition of the Dew Point Gas of the Methane–Water System. R. H. Olds, B. H. Sage, and W. N. Lacey. *Industr. Engng Chem.*, 1942, **34** (10), 1223.—The composition of the dew-point gas of the system methane–water has been investigated over the temperature range 100–460° F., and at pressures up to 10,000 p.s.i. Comparison of these data with similar results for the systems hydrogen–water and nitrogen–water shows that the systems are not ideal, and that the behaviour of such systems must be determined experimentally. J. W. H.

315.* Surface Tension–Viscosity Nomograph for Organic Liquids. D. S. Davis, *Industr. Engng Chem.*, 1942, **34** (10), 1231.—A nomogram is given which relates the surface tension to the viscosity of 32 organic liquids, which include a number of paraffin and aromatic hydrocarbons. J. W. H.

316. Densities of Liquefied Petroleum Gases. Technical Committee, Natural Gasoline Association of America. *Industr. Engng Chem.*, 1942, **34** (10), 1240.—The densities of propane, *iso*butane, *n*-butane, and *n*-pentane in the liquid phase have been investigated over the temperature range − 50° to 140° F., and for propylene and *l*-butene over the range 0–60° F. In addition to these determinations for the pure hydrocarbons, the densities of equimolecular mixtures of propane-*iso*-butane and *n*-butane–*n*-pentane have been determined over the temperature range 20° to 100° F. These densities determinations agree generally with the data previously published. The new densities are somewhat lower for *iso*butane and propylene and higher for *n*-butane. The two mixtures investigated do not appear to deviate appreciably from ideal solutions. J. W. H.

317.* Nomograph for Pressure Drop in *iso*Thermal Flow of Compressible Fluids. G. W. Thomson. *Industr. Engng Chem.*, 1942, **34** (12), 1485.—In *Industr. Engng Chem.*, 1942, **34**, 821, equations were given for the estimation of the pressure drop under the above conditions. The present article gives a nomograph which enables a rapid solution of the equations to be obtained. J. W. H.

318.* Nomographs for the Absorption Factor Equation. S. Chase. *Industr. Engng Chem.*, 1942, **34**, 1499.—Nomographs have been constructed which enable a rapid solution of the Souders and Brown equation for the absorption of gases to be made. From these nomographs the number of theoretical plates required for a given component can be estimated from a knowledge of molal ratio of the gas and absorbent and the equilibrium constant. J. W. H.

319.* Phase Equilibria in the Methane–Decane System. H. H. Reamer, R. H. Olds, R. H. Sage, and W. N. Lacey. *Industr. Engng Chem.*, 1942, **34** (12), 1526.—The specific volumes of five mixtures of methane and decane have been determined over the temperature range 100–460° F. and at pressures up to 10,000 lb. p.s.i. From these data the bubble and dew-point pressures and properties of the co-existing phases have been established. J. W. H.

320.* Binary Mixtures for Testing Fractionating Columns. Correspondence in *Industr. Engng Chem.*, 1942, **34** (12), 1543.—Carlson and Colburn have written a criticism of Bragg and Richards' work on the relative volatility (α) of the binary mixture benzene–ethylene dichloride (*ibid.*, 1942, **34**, 1088). The writers show that, from thermodynamic considerations, the new data are not tenable, and recommend the use of the ideal values of α, calculated from the Smith and Matheson vapour-pressure data, until the experimental technique can be improved, and any deviations from Raoult's

law demonstrated with certainty. In reply, Bragg and Richards maintain that, although individually the determined values of a are subject to large experimental errors, there is overwhelming evidence in favour of the data published. J. W. H.

Analysis and Testing.

321. **A Rapid Infra-Red Analytical Method for Hydrocarbon Mixtures and a Routine Spectrophotometer for Plant Control.** R. R. Brattain and O. Beeck. *J. appl. Phys.*, 1942, **13** (11), 699.—A description is given of two spectrophotometers which operate in the infra-red region and are suitable for the analysis of hydrocarbon mixtures. One is a simple unit for use at 1186 cm.$^{-1}$ wave-band, and is suitable for the analysis of *iso*butane. The other is a more versatile instrument, and is designed to operate in the 2–15 μ region. In this instrument, provision is made for seventeen fixed spectral positions. These instruments consist essentially of a Nernst filament forming a source of infra-red radiation, a rock-salt prism for wave-length separation, and a compensated thermophile and galvanometer for receiving and measuring the intensity of the transmitted radiation. The accuracy of routine analyses for *iso*butane by this method is $\pm$ 0·5%. The average time required for an analysis is 15 mins., but a single operator has analysed thirty-eight samples in 6 hours, including the necessary calculations and other operations incidental to the actual analyses.
J. W. H.

322.* **The Electron Microscope.** C. J. Burton, R. B. Barnes, and T. G. Rochow. *Industr. Engng Chem.*, 1942, **34** (12), 1429.—Methods of calibrating electron microscopes are discussed, and it is recommended that the calibration range be extended well into the optical microscope range so that comparative experience may be gained in the appearance and interpretation of the inspection under the optical and electron microscopes. The electron microscope used by the authors had a range of 200–15,000 diameters, but accurate focusing became difficult at more than 10,000 diameters. A description is given of an attachment to the microscope which enables the range of magnifications to be extended without redesigning the magnetic lense system.
J. W. H.

Motor Fuels.

323. **Patents on Motor Fuels.** Standard Oil Development Co. E.P. 549,075, 5.11.42. Appl. 3.9.40. Preparation of a motor fuel consisting of a hydrocarbon fuel and an organo-substituted borine compound having one or more hydrocarbon groups directly attached to the boron atom, or a nitrogen-base addition compound of the borine compound.

M. W. Kellogg Co. E.P. 549,570, 27.11.42. Appl. 20.8.40. Method of converting a naphtha charging stock rich in aliphatic hydrocarbons into a motor-fuel component rich in aromatic hydrocarbons. The charging stock is contacted in vapour phase with an aromatization catalyst, in the presence of added hydrogen. The net produced hydrogen is afterwards removed.

E. E. Solomon. E.P. 549,908, 14.12.42. Appl. 18.8.41. Production of motor fuels given during the retorting of tar mixed with animal or other fats, alcohol, benzene rectified, acetone, and paraffin oil. After this process the oil is drawn off, leaving the watery part. This watery part is mixed with the residue in the retort with naphthaline crude, sodium nitrate powdered, and dry nitric acid, dry hydrochloric acid, sulphuric acid or other substances like resinous oils, to obtain suitable oil for motor fuel.

Standard Oil Development Co. E.P. 549,963, 16.12.42. Appl. 14.3.41. Process for the catalytic reforming in the presence of hydrogen of hydrocarbon oils containing both saturated and unsaturated hydrocarbons. The activity of the catalyst, and therewith the production of hydrogen, decreases the proportion of saturated hydrocarbons to unsaturated hydrocarbons in the feed-stock.

M. C. K. Jones. U.S.P. 2,303,050, 24.11.42. Appl. 31.10.40. A safety motor-fuel composition of high oxidation resistance and high flash-point consists of a gasoline hydrocarbon boiling substantially within the range 100–350° F., substantially free from molecular oxygen, and containing carbon dioxide in an amount above 100% by volume at about atmospheric temperature.

R. V. Shankland. U.S.P. 2,303,663, 1.12.42. Appl. 30.12.38. Method of producing motor-fuel constituents from a substantially saturated normally gaseous hydrocarbon mixture containing considerable proportions of normal butane and *iso*butane. The mixture is first fractionated in a fractionating zone to form a fraction rich in normal butane and a fraction rich in *iso*butane. A part of the former fraction is dehydrogenated to produce butylenes and hydrogen. The butylenes are introduced with the fraction which is rich in *iso*butane into an alkylation zone containing a catalyst, and are maintained under conditions suitable for the reaction of butylenes and *iso*butane to form branched-chain octanes. The products are removed from the alkylation zone, a normally liquid fraction containing octanes is separated, also a normally gaseous fraction. The normally gaseous fraction is introduced into the fractionating zone. The remaining part of the fraction rich in normal butane is isomerized in the presence of a catalyst of the aluminium chloride type to produce a further quantity of *iso*butane for use in the alkylation zone.

A. R. Goldsby. U.S.P. 2,303,735, 12.1.42. Appl. 10.2.40. Method of improving the anti-knock value of a narrow-cut gasoline fraction of relatively low anti-knock value having an end boiling point not more than 25–75° F. higher than its initial boiling point, and containing substantial proportions of normally liquid olefin and straight-chain paraffin hydrocarbons.

T. A. Mangelsdorf. U.S.P. 2,303,944, 1.12.42. Appl. 16.9.39. To produce high anti-knock gasoline, a hydrocarbon oil is subjected to catalytic cracking in the presence of a solid catalyst adapted to promote conversion into lower-boiling hydrocarbons. Simultaneously another stock is subjected to thermal cracking to effect conversion into lower-boiling hydrocarbons without the aid of a catalyst. Hot products from the catalytic and thermal cracking processes are combined, and the resultant mixture is maintained in a reaction zone in the absence of a catalyst, at a temperature of the order of 900° F. to effect further conversion into hydrocarbons of the gasoline boiling range. The resultant cracking products are separated into vapours and residue. Then the vapours are mixed with charging stock to effect condensation of part of the vapours. The resultant mixture is passed to the thermal cracking zone, and the uncondensed vapours are subjected to further fractionation to separate a reflux condensate from lighter products. The reflux condensate is directed to the catalytic cracking zone.

R. F. Marschner. U.S.P. 2,304,187, 8.12.42. Appl. 8.11.39. A high octane-number motor fuel is produced from a relatively low knock-rating naphtha of wide boiling range in the following manner. The naphtha is fractionated into a number of fractions, including a light naphtha fraction, an intermediate fraction, and a heavy naphtha fraction. The light fraction is contacted with a catalyst under conditions designed materially to increase its octane number. The heavy fraction is contacted with a dehydro-aromatization catalyst to convert the hydrocarbons of lower boiling range intermediate between the light fraction and the heavy fraction. The dehydro-aromatization products are fractionated into a gasoline fraction and a heavier fraction. The gasoline fraction is blended with the high octane-number products of the light naphtha fraction to produce the desired fuel.

C. W. Hussey. U.S.P. 2,304,639, 8.12.42. Appl. 31.8.39. To produce yields of gasoline of relatively high olefin content a hydrocarbon oil is subjected to thermal cracking treatment. The resultant products are separated into vapours suitable for catalytic cracking and non-vaporous residue. The vapours are separated into at least two streams, one of which is catalytically cracked to increase the total gasoline content and decrease the olefin content. Resultant cracked products are fractionated to form reflux condensate and to recover therefrom aviation gasoline fractions. The reflux condensate is combined with another vaporous stream, and an automotive gasoline is separated from the mixture. This gasoline has a higher olefin content than the aviation spirit. H. B. M.

Gas, Diesel and Fuel Oils.

324.* Indian Vegetable Fuel Oils for Diesel Engines. Anon. *Gas Oil Pwr*, May 1942, **37** (440), 80.—This article is concerned with a report issued by the Department of Scientific and Industrial Research Bureau, India, which describes the work of four Indian engineers.

India is one of the principal seed-producing areas of the world, the annual production in 1938 being eight million tons. The most important Indian oils are cottonseed, rape, sesame, coconut, groundnut, and castor.

Previous reports on this subject include papers published by Gautier in France in 1928, 1933, and 1935, papers in German by A. W. Schmidt in 1932 and 1934, some preliminary work by Chinese investigators 1936, and an article in *Gas & Oil Power* by J. Walton, 1938. The Indian report contains a section devoted to the general requirements of diesel fuels, these being divided into : (*a*) handling, storage, pumping, and atomization of fuels, and (*b*) ignition and combustion of the fuel after injection. Section (*a*) covers flash point, specific gravity, viscosity, setting point, and impurities, while (*b*) covers calorific value, chemical constitution, and carbon residue.

The test equipment used for these investigations included a single-cylinder Lister unit 8 B.H.P. at 1200 r.p.m., with bore and stroke $4\frac{1}{4}$ in. and $4\frac{3}{8}$ in. respectively. The engine appears to have been of standard design, with Bosch fuel-pump and single-hole injector, and was provided with a dual-chamber combustion arrangement with starting compression ratio 19 : 1 and operating value 15 : 1. Care was taken to maintain the intake air at constant temperature. The engine was run for 25 hours at approximately three-quarters full load and normal rated speed before the preliminary trial runs were made. Experiments were then made with mineral diesel fuel and a few vegetable oils, with a view to establishing the normal operating conditions under which the various fuels might conveniently be subjected to extended comparative tests. In the preliminary runs general operating characteristics, such as startability, operation stability, nature of exhaust, and maximum output, were determined. Prolonged runs of 50 hours under full load followed, during which average power output, specific fuel consumption, brake thermal efficiency, deposits on engine parts, and corrosion of engine parts were studied.

Results are summarized in detailed tables. It was shown that in comparison with mineral fuels, vegetable oils in general gave comparable average power output, somewhat high fuel consumption, and rather superior thermal efficiency. The deposits were somewhat greater, and in some cases harder. Corrosion on the whole was greater, but varied for the different vegetable oils. The lowest consumption and highest efficiency of all oils including the mineral oil in these 50-hour tests were obtained when using cottonseed oil, and this was confirmed in short-duration check tests.

The results of these experiments and a review of the literature on this subject indicate that from purely technical considerations the use of vegetable oils as diesel fuels holds considerable promise, but that there still remains a number of intricate technical problems to be solved. However, it would appear that several of the oils tested could be used under expert guidance to relieve India's fuel problem at the present time. D. L. S.

325. Patent on Gas, Diesel, and Fuel Oils. G. H. Cloud. U.S.P. 2,304,242, 8.12.42. Appl. 22.3.39. Preparation of a compression-ignition fuel consisting of a hydrocarbon oil boiling between 400° and 700° F. and a small proportion of an essentially hydrocarbon unsymmetrically substituted hydrazine compound selected from the group consisting of dialkylhydrazines, phenylhydrazine, diarylhydrazines, alkylarylhydrazines, quinalylhydrazine, acetylphenylhydrazine, 3-amino-phthalhydrazine. The added compound is an ignition promoter and stabilizing agent. H. B. M.

Lubricants and Lubrication.

326.* Viscosity Characteristics of Lubricating Oils Saturated with Natural Gases at High Pressures. J. D. Swearingen and E. D. Redding. *Industr. Engng Chem.*, 1942, **34** (12), 1496.—A description is given of a capillary-type viscometer for the determination of the viscosities of liquids under pressure. By the use of this apparatus

the viscosities of saturated solutions of four mineral lubricating oils and a sample of castor oil with a natural gas consisting of 90% methane have been determined in the temperature range 80–190° F. and over the pressure range 0–3000 p.s.i. From these data it is shown that castor oil is unique, in that two phases are formed at high pressure and that the viscosity is considerably greater than in the case of the mineral oils. From the data on mineral oils it is shown that the addition of a light oil to a heavy oil to produce an oil of intermediate viscosity substantially reduces the drop in viscosity with subjection of the oil to natural gas under pressure. J. W. H.

327. Patents on Lubricants and Lubrication. W. Helmore. E.P. 548,390, 8.10.42. Appl. 4.4.41.—A lubricant especially suitable to carry high bearing loads at elevated temperatures is prepared from a lubricating-oil base and a small proportion of an oil-soluble organic compound of tin, an organic compound containing trivalent phosphorus, and an organic compound containing a phosphate radical. The total amount of addition agents does not exceed 10% by weight of the lubricating-oil base. Lubricants of this description are claimed to exhibit a marked degree of resistance to oxidation and to the formation of carbonaceous and gummy deposits at high operating temperatures.

Standard Oil Development Co. E.P. 548,723, 21.10.42. Appl. 17.4.40. Production of lubricating compositions by chemically condensing a lubricating oil containing cyclic constituents with an acyl halide of a naphthenic acid in the presence of a Friedal–Crafts catalyst.

Standard Oil Development Co. E.P. 549,040, 4.11.42. Appl. 14.10.40. A lubricating grease has incorporated therein 50–90% by weight of a mineral lubricating oil having a Saybolt viscosity at 210° F. of at least 60 secs.; 10–20% by weight of a sodium soap obtained by saponifying a mixture of equal parts of stearic acid and rosin; and a vegetable wax having a free acid number of less than 20.

Imperial Chemical Industries, Ltd. E.P. 549,296, 16.11.42. Appl. 12.4.41. Preparation of a lubricant consisting of a hydrocarbon lubricating oil to which has been added a minor proportion of a polyvalent metal acid, normal or basic salt of a hydroxyphosphoric acid of the formula $RR'C(OH)PO(OH)_2$. R and R′ represent aliphatic or alicyclic groups in which the total number of carbon atoms is not less than 6.

E. I. De Pont de Nemours. E.P. 549,524, 25.11.42. Appl. 21.5.41. Mineral oils, and particularly viscous petroleum oils, are stabilized against deterioration in colour by the incorporation therein of a small proportion of an oil-soluble ester or amide of an N : N′-alkylene-di(β-amino-crotonic) acid free of acidic substituents.

J. W. Johnson, U.S.P. 2,302,552, 17.11.42. Appl. 7.4.38. Lubricating oil can be purified, and an effective concentration of addition agent maintained therein, by means of a special device which comprises, in series, a porous filtering medium and a porous absorbent medium impregnated with an organic addition agent soluble in lubricating oil in relatively low concentrations.

S. Musher. U.S.P. 2,302,708, 24.11.42. Appl. 23.4.40. The tendency of lubricating oils towards sludge formation can be decreased, also their tendency to cause corrosion of metal surfaces, by treating them with a relatively small amount of a combination of molasses and a phosphatide at a high temperature.

G. H. Schoenbaum. U.S.P. 2,303,068, 24.11.42. Appl. 27.4.40. Preparation of a lubricant suitable for heavy mechanical equipment, such as tractor roller bearings which are exposed to dust and dirt during use. The lubricant consists of 50–90% of a mineral oil having a viscosity between 200 and 250 secs. Saybolt at 210° F., and a flash point of at least 600° F.; 1–25% of a finely divided fibrous solid suspended in the mineral-oil base stock; and 5–40% of petrolatum having a melting point not lower than 110° F. The amount of petrolatum should be sufficient to stabilize the composition against separation of the fibrous solid during storage.

H. G. Greger. U.S.P. 2,303,546, 1.12.42. Appl. 8.8.39. Impurities are separated from lubricating oils by mixing with them a compound of the guanidine series and afterwards filtering the mixture. H. B. M.

Asphalt and Bitumen.

328. Patent on Asphalt and Bitumen. H. E. Cier. U.S.P. 2,303,023, 24.11.42. Appl. 19.12.40. Asphalts having improved susceptibility characteristics to temperature changes are prepared by fluxing a reduced crude with a low-viscosity hydrocarbon fraction boiling within the lubricating-oil range. The mixture is diluted with a liquefied gaseous hydrocarbon, and the temperature is so adjusted that an asphalt is precipitated from it. Precipitated asphalt is separated from the portion which is soluble in the diluent, and finally the asphalt is stripped free of light hydrocarbons.
H. B. M.

Special Products.

329.* Cryoscopic and Viscosity Studies of Poly*iso*butylene. A. R. Kemp and H. H. Peters. *Industr. Engng Chem.*, 1942, **34** (10), 1192.—Cryoscopic and viscosity data have been determined for solutions of various poly*iso*butylene polymers in various solvents. The constant in the molecular weight–viscosity equation has been determined for various degrees of polymerization. The cryoscopic deviation from Raoult's law begins when the molecular weight of the polymer exceeds 2300, corresponding to a chain length of 80 carbon atoms. *n*-Hexane is the best solvent for the viscosity–molecular weight measurement of poly*iso*butylenes. J. W. H.

330.* Low-Temperature Flexibility Behaviour of Vinyl Elastomers. R. F. Clash and R. M. Berg. *Industr. Engng Chem.*, 1942, **34** (10), 1218.—A description is given of an apparatus for the measurement of the flexibility of elastomers at temperatures down to $-75°$ C. In this apparatus a strip of the elastomer, at a controlled temperature, is subject to a torsional stress which can be measured. By means of this apparatus the flexibility–temperature relationship has been established for samples of vinyl copolymer resins to which have been added various amounts of different plasticizers. J. W. H.

331.* Spraying Solutions in Liquefied Gases for Insecticidal Aerosol Production. L. D. Goodhue. *Industr. Engng Chem.*, 1942, **34** (12), 1456.—The spraying of insecticides, such as pyrethrum extract and nicotine, from solutions in liquefied gases results in much more finely divided mists than those produced by most spraying methods. These mists settle more slowly than sprays, and measurements of the rate of settling are given. Suitable non-inflammable gases for this type of spraying are methyl chloride and dichlordifluoromethane. J. W. H.

332.* The Effect of Sulphur and Nitrogen Compounds on Liquid Dielectrics. J. D. Piper, A. G. Fleiger, C. C. Smith, and N. A. Kerstein. *Industr. Engng Chem.*, 1942, **34** (12), 1505.—Measurements have been made of the power factors, conductivities, and polar contents of systems of liquid paraffin with sulphur and nitrogen compounds selected to represent types found in insulating oils, or formed from them as the result of deterioration in service. Sulphur and nitrogen compounds of the types occurring in natural petroleum had low power factors and conductivities even when present in high concentrations. The presence of soluble salts resulting from the reaction between nitrogen bases and carboxylic acids can cause high power factors, but not when present in the quantity comparable with nitrogen content of insulating oils. Sulphonic acids, such as lauryl sulphonic acid, result in high power factors which are greater than those produced by the concentrations of asphaltic deterioration products. J. W. H.

333. Patents on Special Products. J. G. Fife. E.P. 548,733, 22.10.42. Appl. 21.4.41. Process for the separation and recovery of hydrocarbons of a lesser degree of saturation from hydrocarbons of a greater degree of saturation contained in hydrocarbon vapour mixtures of relatively narrow boiling range. The vapour mixture is contacted with a liquid solvent of the group consisting of acetonitrile, propionitrile, nitromethane, nitro-ethane, and nitropropane, to dissolve selectively the hydrocarbons of lesser degree of saturation. The residual gas is separated from the liquid solution containing these hydrocarbons, which are afterwards recovered.

J. G. Fife. E.P. 548,734, 22.10.42. Appl. 21.4.41. Process for the recovery of hydrocarbons of a lesser degree of saturation from hydrocarbons of a greater degree of saturation contained in hydrocarbon vapour mixtures of relatively narrow boiling range. The original mixture is contacted with a liquid solvent mixture consisting of 5–55% by weight of water and 95–45% of a compound of the group consisting of morpholine, dioxane, acetone, methyl ethyl ketone, acetonitrile, and lactonitrile, to dissolve selectively the hydrocarbons of lesser degree of saturation.

Anglo-Iranian Oil Co., Ltd. E.P. 548,901, 29.10.42. Appl. 2.4.40. Process for the isomerization of a normal hydrocarbon having at least four carbon atoms in the molecule. The normal paraffin, or paraffins, or mixtures of hydrocarbons containing such normal paraffins, are contacted, in the absence of hydrogen, with a catalyst consisting of an oxide and/or sulphide of a metal of Group VI of the periodic table.

R. M. Barrer. E.P. 548,905, 29.10.42. Appl. 24.2 41. Method of separation of straight-chain hydrocarbons from mixtures containing straight-chain hydrocarbons, branched-chain and/or cyclic hydrocarbons. The mixtures are contacted with crystalline natural or synthetic zeolites having rigid three-dimensional anionic networks and having interstitial dimensions sufficiently large to absorb the straight-chain hydrocarbons, but small enough to exclude the branched-chain and/or cyclic hydrocarbons.

Kodak, Ltd. E.P. 548,907, 29.10.42 Appl. 21.3.41. A process for scrubbing coal gas and other gases with a mineral oil in which there has been incorporated one or more of the organic substances: xylenols, phenolic ethers, naphthols, hydroquinone, pyrogallol, coal-tar distillates boiling within the range 140–300° C., and pine and other soft-wood phenols and oils.

Kodak Ltd. E.P. 548,908, 29.10.42. Appl. 21.3.41. A process for scrubbing coal gas and other gases with a mineral oil in which an aminophenol has been incorporated.

Anglo-Iranian Oil Co., Ltd. E.P. 549,003, 3.11.42. Appl. 2.10.40. Method of conversion of normal saturated aliphatic hydrocarbons, such as *n*-butane or *n*-pentane, into substantial proportions of the corresponding branched-chain hydrocarbons. The conversion is carried out in the presence of an aluminium halide and a solvent selected from carbon disulphide or a chloro-paraffin such as tetrachloroethane.

Standard Oil Development Co. E.P. 549,233, 12.11.42. Appl. 3.7.40. In the isomerization of normal paraffin hydrocarbons the normal paraffin is subjected at a temperature of 30–400° F. to the action of a metal such as will, with a halogen-containing compound, form a Friedel–Crafts type catalyst, and a halogen-containing compound capable of reacting with the metal to form metal halide. In this way a nascent Friedel–Crafts catalyst is prepared *in situ*.

Standard Oil Development Co. E.P. 549,702, 3.12.42. Appl. 2.12.40. Preparation of a composition consisting of a mineral oil or a petroleum hydrocarbon and a relatively small amount of a tertiary alkyl ether of a mono-hydroxy phenol having at least two alkyl groups attached to the ring nucleus, and in which two of the alkyl groups are attached to the nucleus by a carbon atom having a hydrogen atom attached thereto, or in which one of the alkyl groups is a tertiary alkyl group and another is a primary or secondary alkyl group containing at least two carbon atoms.

Standard Oil Development Co. E.P. 549,829, 14.12.42. Appl. 24.7.40. A liquid-phase process for the isomerization of normal paraffins containing at least four carbon atoms into *iso*paraffins. The catalyst employed is of the Friedel–Crafts type, and is maintained in an amount of at least 100% by weight of the amount of feed-stock in contact with it at any given moment.

J. T. Rutherford. U.S.P. 2,302,655, 17.11.42. Appl. 18.12.39. Process for preparing a homologous mixture of heterocyclic secondary amines having a basic dissociation constant higher than $1{\cdot}0 \times 10^{-4}$. An initial mixture of petroleum nitrogen bases being substantially free of hydrocarbons and petroleum-derived impurities insoluble in an excess of 50% H_2SO_4 is recovered from petroleum. The mixture is

then subjected to the action of hydrogen under reducing conditions, in the presence of a sulphur-active hydrogenating catalyst and an active sulphur carrier. Secondary amines thus produced are separated from the normally liquid reaction mixture by adjusting the *p*H of the mixture to approximately 9·5. H. B. M.

Coal and Shale.

334. The Physical Properties of Cokes from Bureau of Mines—American Gas Association Tests at 800° and 900° C. D. A. Reynolds and C. R. Holmes. *U.S. Bur. Mines Report of Investigations*, No. 3650, June 1942.—The carbonizing properties of sixty-six American coals and a number of coal blends have been determined by means of the Bureau of Mines, American Gas Association (BM-AGA) test. Many of the coals were carbonized at 800° and 900° C. in two sizes of retort. Because the quality of the coke was found to be affected by the size of the retort, this report was prepared to show the average physical properties of coke from two sizes (13- and 18-diameters).

Conclusions reached as a result of such tests are as follows. Cokes from the two sizes of retort do not differ appreciably either in apparent specific gravity or hardness. The 800° cokes from the two sizes have about the same 1½-inch shatter and 1-inch tumbler indexes. The 900° cokes from the 18-inch retort generally are stronger; they have higher 1½-inch shatter and 1-inch tumbler indexes than cokes from the 13-inch retort made at the same temperature. The physical properties of the coke were found to be related to the rank of coal carbonized. As more coals were carbonized at 900°, comparison of the properties of cokes on the basis of carbonizing temperature was not entirely valid. The 1½-inch shatter index was definitely higher for the 800° cokes from all ranks of coal, whereas differences for the 1-inch tumbler index were small, with no definite trend for this index to be higher at either carbonizing temperature. H. B. M.

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Correlation of Certain Properties of Oil-Well Drilling-Mud Fluids with Particle-Size Distribution. G. L. Gates and C. P. Bowie. U.S. Bureau of Mines, Report of Investigations, R.I. 3645, May 1942.

British Electrical and Allied Industries Research Association. Twenty-second Annual Report. 1st October, 1941, to 30th September, 1942.

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La Geoquimica de los Filones Vanadiferos. G. A. Fester, V. Lombardozzi, and M. A. Solchaga. University of Santa Fé.

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Geology and Development.

335. Edison Oil-Field. F. E. Kasline. *California Oil Fields*, Vol. **26**, July 1940–June 1941.—The Edison oil-field is situated about 9 miles south-east of Bakersfield, Kern County, and has a proved acreage of 1360 acres, divided between North-west Edison area (110 acres), West Edison area (120 acres), and Edison area (1130 acres). According to this report, the first completion for the entire area was in the North-west Edison district in 1928, and up to the end of 1941 there were ten producing wells in the same area, two of which were idle. Production is from the "Wicker" sand, a sandy interval found at the base of the Fruitvale shale. The area is complicated by faulting.

In 1931 two wells were drilled in Edison area and 50 brl. per day of 13·7° gravity oil were obtained from one of them. No further drilling was done until 1933, when Monterey Exploration Company acquired certain rights. Drilling continued, and by

the end of 1934 there were ten producing wells in the area. In 1937 and 1938 five wells were completed and seven unsuccessful ones were abandoned. In 1939 and 1940 there was no new activity, but in 1941 eight new wells were completed.

West Edison area was first proved in 1935, and in January 1939 nine wells were being pumped at the daily average rate of 55 brl. of oil and 8 brl. of water. In 1940 four new wells were drilled, and in 1941 five, raising the total number of producing wells to eighteen. Throughout the field, water suitable for irrigation may be obtained from sands at depths between 200 and 600 ft. H. B. M.

336. Résumé of Oil-Field Operations in 1940. R. D. Bush. *California Oil Fields*, Vol. **26**, July 1940–June 1941.—It is reported that total production in the State of California for the last six months of 1940 amounted to 112,323,908 brl. of oil and 108,615,985 brl. of water. The total for the whole year was thus 223,292,063 brl. of oil, a decrease of 961,730 brl. as compared with 1939. Nevertheless there was a substantial increase in production of oil in the second half as compared with the first half of 1940.

Tables included in the report give summarized production records of the five State districts over six-month periods of 1939 and 1940; segregated data of production of clean oil and water in various fields for the half-year ended 31st December, 1940; average daily and closed-in production by months for each field for the year 1940; and average daily production and disposition of natural gas by fields monthly for the year 1940.

At the end of 1940, as computed from American Petroleum Institute statistics, there were 145,566,524 brl. of crude and refined petroleum in storage in Pacific Coast territory. This represented a decrease of 6,368,724 brl., compared with a decrease of 5,749,041 brl. in 1939.

6,467,000 brl. of crude and refined oil were shipped to Atlantic Coast ports during the year, or 491,000 brl. less than in 1939.

On 1st February, 1940, prices of crude oil were decreased: heavy crude oils were cut 15% while higher-gravity oils were cut proportionately less.

During 1940 only one new oil-field, Del Valle in Los Angeles County, was discovered, but new productive areas were developed in already known fields, chiefly at Dominguez, Rosecrans, and Wilkington in Los Angeles County and at Trico Gas, Kern County. H. B. M.

337. Webster Area of Midway-Sunset Oil-Field. R. N. Ayars. *California Oil Fields*, Vol. **26**, July 1940–June 1941.—The Webster area of the Sunset oil-field of the San Joaquin Valley is situated in low foothills cut by numerous erosional valleys. In 1920 R. W. Pack (U.S.G.S. Prof. Paper No. 116), described two producing zones in the area, but since that time a deeper Miocene producing interval has been located, known as the "Webster" zone. This report describes the deeper strata and correlates Pack's findings with the further information now available.

Structurally, the Webster zone interval is the upper end of a plunging anticline which ends in an elongated dome where the anticline intersects the monoclinal trend of the beds along the west side of the valley. There is approximately 400 ft. of closure on the dome. The zone is from 1600 to 2100 ft. and has a total thickness of from 200 to 300 ft. In the upper 150 ft. the sand averages about 50% of the total thickness, but in the lower part the proportion is considerably less. In most cases the oil-saturated sand is found in the first 200 ft. of the zone. The oil-sands are not continuous, neither do they occur at the same stratigraphical horizon throughout the area owing to the lenticular character of the formations.

Total maximum proved acreage of the Webster zone is reported as 315 acres with potential locations for sixty-three wells with 5-acre spacing; twenty-seven commercial wells have been drilled. Wells below the minus 1000 contour in a heavier drilled area to the south-east make considerable amounts of water, in one case up to 90%. Total initial production from all twenty-seven wells was 2964 brl. of oil, 13·9–15·6° gravity, and 261 brl. of water per day. In September 1940 the total for twenty wells was 813 brl. of oil and 2234 brl. of water per day. These figures indicate the small amount of water produced originally as compared to the large amount now being produced. H. B. M.

338. **Wilmington Oil-Field.** W. J. Crown. *California Oil Fields*, Vol. **26**, July 1940–June 1941.—Wilmington oil-field is situated in the harbour district of the City of Los Angeles and has all the advantages of a field in the immediate vicinity of refineries and a busy harbour. According to this report, it is of especial interest, in that it was the first large town-lot field in which the State law was applied to regulate the spacing of wells; it is one of the few multiple-zone fields discovered in many years; of the Los Angeles Basin fields, it is second largest in areal extent; it contains one of the largest reserves of oil in the State; gasoline obtained from the crude oil has probably the highest octane rating in the entire State; and oil-zones are shallow.

Structurally, the field is classed as an anticlinal fold with its main axis trending in a north-westerly–south-easterly direction and cut by a series of transverse faults which in some cases branch out into minor faults.

Production is obtained from four zones: Tar and Ranger of Pliocene age and Terminal and Ford of Miocene age. Oil in Tar zone, as its name indicates, is heavy, with a gravity range of 13–15° A.P.I. Within the Ranger zone there is a considerable change in sedimentation and the widest gravity range of any zone is found—*i.e.*, 14–24° A.P.I.

The Terminal zone is normal as to sedimentation. In the upper part, gravity of the oil varies between 17° and 26° A.P.I., while in the Lower Terminal zone it ranges between 27° and 31° A.P.I. Production in the Ford zone comes from a 700-ft. interval of which 150 ft. is sand. Gravity of the oil is between 29° and 31°. With the exception of those in the Ford zone, all the sands are relatively high in porosity and permeability.

It is recorded that a large part of the field, chiefly where only the Ranger zone is productive, has not yet been developed, and it is the author's opinion that if and when all zones are developed by opening up undrilled portions, ultimate recovery from all zones will be approximately 700,000,000 brl. By 1st January, 1942, 140,201,679 brl. had been produced, leaving an estimated reserve of 559,898,321 brl. Hitherto, the field has averaged 35,050 brl. per acre, and it has accordingly a potential ultimate recovery figure of 175,000 brl. per acre. It is further estimated that the future life of the field will extend over more than thirty years, and that it will play a major part in the Californian oil industry for many years to come. H. B. M.

339.* **War and Wildcatting.** Anon. *Petrol. Engr*, December 1942, **14** (3), 14.—For the past ten or twelve years the U.S.A. petroleum industry has been in a position to produce a raw material and its finished products in quantities far greater than the consumptive demand, but this condition no longer holds. The expanding need for petroleum products will fully test the ability to produce and manufacture, and a maximum rate of withdrawal from underground oil reserves seems imminent. Frequently the U.S. oil reserve figure has been given as 20,000,000,000 brl., and many have accepted this quantity as being available for the war effort, but the quantity which is significant is that which will be available during the next two or three years. This latter is not the same as the figure quoted above.

The decline in discoveries over the past five years, the lack of development in proven and semi-proven areas, and the cessation of wildcatting for new reserves in twenty oil-producing States show that the U.S. production will be approximately 1,349,650,000 brls., 1,283,100,000 brl., 1,189,525,000 brl., 1,086,555,000 brl., and 995,610,000 brl., in 1943, 1944, 1945, 1946, and 1947 respectively.

A study of the history of oil production and the economics of various methods of recovery reveals that it would take forty years to recover 16,360,000,000 brl. of the estimated reserve of 20,000,000,000 brl. In the period 1943–7 inclusive only 5,904,000,000 brl. are likely to be available without severe water contamination.

The barriers to wildcatting must be lowered, and the wildcatter should be given a price which will encourage speculative undertakings, or else there will be a shortage of crude or of the required types of crude. G. D. H.

340.* **November Wildcatting Fails to Provide Adequate New Fields.** J. L. Logan. *Oil Wkly*, 21.12.42, **108** (3), 14.—In November the number of exploratory tests completed was only 75% of the average number set by the C.P.O. as the monthly goal this year. Few if any major strikes were made, and two-thirds of the new fields and pays were in areas where the discoveries are generally not large—namely, Illinois, Indiana, Kansas, North Texas, and West Central Texas. In spite of con-

siderable wildcatting, no discoveries were made in California, Arkansas, Mississippi, New Mexico, East Texas, Upper Texas Gulf Coast, Louisiana Gulf Coast, Michigan, and Kentucky.

Eighteen new fields and eleven new pays were discovered, a total of only twenty-nine instead of the monthly average of fifty-two hoped for. Eight gas-fields were discovered, while ten were expected. The Robertson field of West Texas is one of the more important November finds, and produces from the Permian at 5010–5950 ft., but more development is needed to fix its value. It is on an anticline located by geophysics and subsurface geology. Oil was also found in the Clear Fork sandy lime of the Monahans field, the new pay coming in at 759 brl./day from 5633—5643 ft. The previous development was in the Ellenburger at 10,345 ft. A deep high-gravity oil-field and new pay, and a shallow oil-field were found in Jackson County on the Lower Gulf Coast of Texas. In Young County two new Mississippian pays were opened, and North Texas had two other new pays and three new fields. A shallow gas-field and a minor shallow oil-field have been found in West Central Texas. Tensleep oil production has been obtained in the Elk Basin field of Wyoming, which has given oil from the Frontier sands. The new Horse Creek field of Laramie County, Wyoming, yields oil from the Lakota at 5451–5510 ft.

Tables give the results of wildcatting in November 1942, by States and districts, and list the new oil-fields and pays, with data on depths, formation, production, type of structure, date, and method of discovery, etc. G. D. H.

341.* Are Salt Domes Genetically Related to Zones of Crustal Megashearing? A. Keith, *Oil Wkly*, 21.12.42, **108** (3), 24.—The principal zones of megashearing of the Gulf Coast area have been mapped, primarily on in-line evidences of vulcanism in its many forms, and on the bulky data about the co-axiality of many recognized structures, with extrapolation across the numerous intervening masked areas. It has been noted that nearly all the more important salt domes of Louisiana are within or near the two east–west zones of crustal mobility. These are tangential to the Gulf coasts. In Texas the principal domes are near the great negative arc which defines the coastline, and a rectilinear zone which transects Louisiana from the north-east and is tangent to the Texas coastline near Corpus Christi. Submarine salt-domes have been found bordering a long, deep, nearly rectilinear trough, which is in line with another megastructure.

Minor alignments of salt-domes have been noted for a long time. Seismological data show that the great zones within which most of the salt-sulphur domes lie have also been centres of numerous seismic disturbances.

It seems that the shaping of the Gulf has been attended not only by strong downward crustal bending, but also by deep near-shore penetration of the crust. This assumption gives a reasonable solution of a number of puzzling salt-dome problems, and suggests the whereabouts of the more promising areas for future drilling. G. D. H.

342. Geology of North-west Wilmington and Torrance Fields, California. W. R. Cabeen and A. L. Hunter. *Oil Gas J.*, 14.1.43, **41** (36), 70.—The Wilmington oil-field is a transversely faulted anticlinal nose, plunging north-west. The various fault blocks differ as regards oil gravity, gas/oil ratio, productivity, and edge-water limits. Shallow production comes from the Tar zone of Middle Repetto (Pliocene) age. The Ranger (Pliocene) and Terminal (Miocene) zones are not productive throughout the town-lot area. The Ranger zone is 240 ft. thick, and lies immediately above an unconformity. The Ford zone is productive only in the south-east part of the town-lot area. It is 700–800 ft. thick. The Lower Terminal and Ford zone possibilities have not been fully exploited.

The Main zone production at Torrance is roughly equivalent in age to the upper Terminal of North-west Wilmington, while the Del Amo producing zone is roughly equivalent to the lower-middle and upper-lower part of the Ford zone at Wilmington. Torrance is a complex structural nose plunging south-east, and generally agreeing with an irregular ridge of the basement schist. The north-westerly rising schist ridge changes direction when it nears the coast and becomes more northerly in trend. The Del Amo production is generally limited to the south-west flank of the structure, while the Main zone production is chiefly on the north-east flank. The structural closure decreases with distance above the basement, but not so rapidly as would be

expected if it were wholly due to thinning and differential compaction of the beds over the ridge. Near the Torrance Harbour City area the Torrance nose dies out in a south-easterly direction into the flank of the Wilmington structure, whereas the Wilmington nose dies out in a north-westerly direction into the flank of the Torrance structure.

The movement of the faults of the North-west Wilmington plunging nose was largely horizontal, little vertical movement being apparent. G. D. H.

343.* December Wildcatting Yields but One First-Class Field. Anon. *Oil Wkly.* 18.1.43, **108** (7), 18.—During December 1942, 201 wildcat wells were completed, less than two-thirds of the number considered to be the safe minimum monthly average. The discoveries were mainly of a secondary or minor importance, 17·9% of the wildcats being successful. There were nineteen new oil-fields, three distillate fields, four gas-fields, and ten new pays in established fields. The O.P.C. programme is based on the drilling of sixty-two successful wildcat wells per month, ten of which should prove new gas-fields.

Only one out of the thirty-six discoveries seems likely to be an important field, although a second is important because of its remoteness from areas of established production. The important strike was at Quitman in Wood County, East Texas, 7½ ml. south-west of the young and important Coke field. The discovery well flowed at the rate of 726 brl./day, with a G.O.R. of 316 and a casing pressure of 660 lb./in.². The oil is from the Paluxy at a depth of 6280–6310 ft. The field is on an anticline outlined by geophysics and geology, and it may have further pays in the Lower Trinity.

The East Strand field of Kern County, San Joaquin Valley, discovered late in November 1942, is estimated to have a reserve of at least 5,000,000 brl. A 125-brl./day pumper has been opened in Clarke County, Mississippi, and this field promises to lead to more prospecting which may extend into Alabama.

A new shallow field and new zones in three established fields have been opened in Illinois. About 50 brl./day were obtained from the discovery wells of each of the five new fields of Kansas. Oklahoma had a new oil-field, a new gas-field, and a new pay. A poor producer was completed in Wise County, North Texas.

A table summarizes the results of wildcatting in the various States and districts in December 1942. G. D. H.

344.* New Oil- and Gas-Fields and New Pay Horizons Discovered in the United States. Anon. *Oil Wkly,* 18.1.43, **108** (7), 19.—A table gives data about the thirty-six successful wildcats completed in December, and in some cases in November 1942. The data include name, county, company, well location, distance from pipe-line, date spudded, date completed, total depth, depth of completion, name, age and type of producing formation, initial production, mode of production, oil gravity, type of structure, and method of discovery. G. D. H.

Geophysics.

345.* Radioactivity Determinations Set Production Delimitations. R. A. Stothart. *Oil Wkly,* 4.1.43, **108** (5), 19.—The precise determination of radioactivity at the earth's surface is not now generally considered to be capable of locating possible oil reserves, because of the inability to distinguish between emanations from oil deposits and from certain buried minerals. However, it now seems to be possible clearly to define the productive limits of a field once a well has found oil and the radioactive characteristics of the locality have been determined.

Crude oil has a relatively large capacity for absorbing radioactive emanations, and this feature is apparently its sole source of radioactivity. It absorbs 40–50 times as much radon as does water at temperatures between 20° C. and 50° C., and so only hot, highly mineralized waters are likely to approach crude oil in radon-absorbing capacity. Natural gas does not absorb radon. A variety of rocks which might provide the emanations absorbed by crudes have been examined, and also the crudes from the fields where the rocks were obtained. The crudes were found to contain several times more radon emanation than might be expected from a study of the rocks.

In finding the limits of production in an area with a producing well, 4-ft. holes are drilled, and a sample of gas is drawn from the bottom of the hole for a determination of its degree of radioactivity. On plotting a profile of the intensity of emanation, the best oil production is found in the crestal region of the profile. The method has been tested on wedge, fault, and other types of oil-fields, and good agreement found with the drilling results. The thinning of oil-sands is also indicated.

The method may reduce, if not remove, the need for drilling a series of dry holes in order to define the limits of commercial oil production in a field. G. D. H.

Drilling.

346.* Revised Operating Practices Prolong Rig Service. E. Sterrett. *Oil Wkly*, 9.11.42, **107** (10), 41.—In a long paper, maintenance hints and methods are detailed with a view to lengthening the life of drilling equipment. Mud pumps and lines, draw-works and their component parts, drill-strings and bits, boilers, and paint on all this equipment are each discussed separately. Since the preservation of the metal is dependent on the continuity of the protective coating, paint now stands high in the list of maintenance "tools," and regular painting is incorporated in the work schedule. Equipment which is temporarily idle, such as sand-line equipment, is cleaned and painted at the first opportunity. Cleaning, not just wiping off with a rag moistened with kerosine, is now required before the paint is applied. Where steam is available on the rig, most parts which have acquired coatings of dirt and grease are steam-cleaned by flushing off all surfaces with a jet of steam, loaded with water or kept as dry as possible, depending on the equipment being cleaned and the arrangements for proper drainage of the run-off.

If the equipment is paraffin-coated, as is often the case on work-over jobs, the addition of some commercial solvent to the steam-jet greatly speeds up the cleaning, and also leaves the surface in condition for painting without the need of wiping down. An item of equipment, steam-cleaned, will dry quickly unless pockets retain condensation, and the painting may follow closely behind the steam hose. Care must be exercised with the use of the steam-jet to prevent the force of the flow forcing grit and water into close clearances in the joints of certain equipment, packing, and similar points; but for the preparation of broad surfaces the jet is fast and saves much hand labour. Flame-cleaning of drilling-rig equipment is confined to relatively few items of the operating class, though it may be used on boilers, stacks, steel mud-pits, flumes, steam- and mud-lines, without injury to the material being prepared for painting. It is also useful in cleaning the racks made of old pipe, but should not be used on any galvanized steel, such as derrick substructure and beams, even though the condition of the galvanized coating is so bad as to require painting as a matter of preservation rather than to preserve appearances. The procedure of painting and maintaining the coating is detailed.

Hot enamel coatings, such as those used for protection of pipe-lines, are being used by some companies for much of the equipment formerly considered fully expendable. The big-inch pipe used as mud flumes on many rigs, for instance, is thoroughly cleaned, and then given a brush coat of enamel inside and out. This coating is highly resistant to the scouring of the cuttings carried in the mud-stream, and if given proper care during location shifts, the flume will outlast several using bare pipe alone. Other items coated with hot enamel are water- and mud-lines, pump-skids, and other equipment which must lie on the ground throughout the drilling programme. The enamel may also be used on steam-lines to advantage if they are to be lagged, but otherwise the temperature of the steam inside the lines is too high to permit the coating to retain the desired hardness. A. H. N.

347.* Rebuilding by Metallizing for Surface-Wear Extension. Anon. *Oil Wkly*, 9.11.42, **107** (10), 64.—Wear of bearings and other contacting parts in oil-field equipment may be segregated into two general classes: that in which the wear impairs the structural strength of the units and increases hazards; and that in which abrasion increases clearances and encourages leaks without reducing the initial factor of safety below the point of safe operation. In the latter class may be set much of the wear on such reciprocating parts as pump plungers, engine pistons, crossheads and guides,

and compressor rods; oscillating parts such as pumping-unit irons, plug-valves, and cam-follower pins; and rotating parts such as cam-shafts, crankshafts, sheaves, and follower rollers. Almost without exception, design of these parts is to a specified factor of safety, with the limiting dimension being taken as the next commercial size greater than that indicated by evaluation of the design formulæ.

Where such wear is known or may be demonstrated to have left unimpaired the initial design factor of safety, application of additional metal through metallizing enables the low spots to be built again to dimensions, the desired surface finish again attained, and the part thus restored to service. Metallizing is not to be considered as a welding operation. No fusion of metal between that of the part under repair and the stream of molten particles issuing from the spray-gun is attained. The bond is purely mechanical, and as such cannot be considered as adding to the tensional, torsional, or bending strength of the part. The sprayed film is, however, resistant to compression or crushing to the extent to which the added metal is itself resistant or, if hard metal is being applied over softer core material, to the extent the core is resistant.

The method is described in detail (*see* Abstract No. 363 in the Production section for similar description). A. H. N.

348.* Chain-Drive Maintenance Pivots on Lubrication. Anon. *Oil Wkly*, 9.11.42, **107** (10), 72.—While the installation of a chain is not difficult, reasonable care should be used in its operation and maintenance. The greatest handicap to the dependability and serviceability of roller chains is avoidable abuse. Periodic inspection, good maintenance, and, most of all, correct lubrication, will prevent the necessity for replacing chains and sprockets prematurely. To secure maximum life and efficiency, the three factors of chain alignment, chain adjustment, and chain lubrication should be frequently checked to ensure preservation of conditions attained at time of installation.

Shafts must be parallel, level, and rigidly mounted. Sprockets must be in line with each other and securely fastened to the shafts. Inner faces of inner links should be examined for wear from contact with the teeth of sprockets improperly adjusted for all drive factors. The sides of the sprocket teeth should be examined for wear, this being consequent to misalignment and non-parallelism of shafts, and conditions thus indicated should be corrected before the maladjustment has caused serious deterioration of the drive. Link-plate outer edges should be examined, and any highly localized brightness should be regarded with suspicion as this, in common with tight joints, may be traced to the running of the chain with inadequate clearance, the links striking against some obstruction. Centre distances should be adjusted occasionally, on such drives as permit this aid to prolonging drive life, to take up slack as it develops.

Details are given for the proper use of lubricants and for the correct placing of idlers to ensure maximum life of chains. Chain repair is briefly discussed. A. H. N.

349.* Better Wire-Rope Care Will Pay Big Dividends. Anon. *Oil Wkly*, 9.11.42. **107** (10), 104.—Cleaning wire ropes before lubrication is fully discussed. Since not only the individual wires, but the strands themselves tend to open up and move with relation to one another when passing around a sheave, lubricant should be applied at a bend in the line if at all possible. If the sheave itself is so located as to prevent the application at this point of principal bending, the lubricant should be added just before the rope, in normal travel, would pass between the flanges. Also, when running a line for lubrication, the usual high speed should be cut down so as to allow a brief period for the lubricant to penetrate between the wires and find its way to the core. The lubricant should be acid-free and not water soluble. It must form a tenacious film and penetrate readily, as tiny interstices open between wires. If any doubt exists as to the proper lubricant to apply, the specifications available from any wire-rope maker should afford an accurate guide.

One function of wire-rope lubrication, which is little understood by many users, is that of keeping the hemp core soft, pliable, and swelled to proper size. A dry core will shrink, withdraw its support from the strands, and allow them to crush one another, as well as to break down the fibres of the core itself. A well-lubricated core acts as reservoir for lubricant, feeding a little to the adjacent wires at each flexing over a sheave. On the contrary, a core lacking lubricant to fill the pores of the fibre, will

soak up water during wet weather, keeping the inner wires moist and greatly encouraging the formation of rust, with eventual weakening or breaking of the wires thus exposed to severe conditions. Different types of lubricants are discussed with their special uses. Proper methods of spooling and general maintenance of ropes in use are indicated.

Replacement of smooth drums with spirally grooved units adds greatly to the life of a line. There is available a spiral grooving which may be welded or brazed to a smooth drum, and no dismantling or change of equipment be required. Drums which have worn may be rebuilt by metallizing or welding while still in place, and should be checked after repair to ensure the proper groove depth and pitch. If concentric grooves are used, the depth should not exceed 10% of the rope diameter, or severe crushing will be sustained by the rope at each crossover. The spiral groove should be of sufficient depth to support the rope through an arc of contact of 150°, and clearance between adjoining grooves should be such as to insure $\frac{1}{8}$-in. space between adjoining turns of the line on the drum for all sizes from $\frac{1}{2}$ to $1\frac{1}{2}$ in., and $\frac{3}{16}$ in. for larger sizes. A drum re-worked to include these factors may cut the loss through drum crushing to one tenth of that formerly sustained. A. H. N.

350.* Hydration-Pressure Relations in Clays and Heaving Shale. H. H. Power, B. L. Towle, and J. B. Plaza. *Oil Gas J.*, 12.11.42, **41** (27), 215. *Paper Presented before American Petroleum Institute.*—Some shales are thought to heave into the bore-hole of drilling wells because of the inclusion of varying quantities of clay materials which swell and expand when wetted by water from the drilling mud. The expanded shale not only fills the hole a large distance above the point of entry, but in some cases also exerts sufficient pressure to crush the steel casing. A survey of the literature indicates that little has been written concerning the swelling of clay minerals. Most of the literature on swelling is confined to descriptions of experiments performed with the so-called elastic gels. Hence, opportunity exists for research in this field, with due regard for the accomplishments to date in allied investigations.

Accordingly, a programme of investigation was initiated in the petroleum engineering laboratories of the University of Texas in order to determine the hydration-pressure relationships existing in clay materials, such as Wyoming bentonite, when wetted with water. The conclusions reached from this work indicate that certain clay materials are capable of producing pressures of considerable magnitude when confined during hydration. The effects of certain chemicals on pressure increases or decreases are also shown. It is also apparent that the nature of the exchangeable bases present may influence the swelling-pressure characteristics of the clay material.

The present work was intended only as an extended test of the hydration-pressure bomb. No single line of investigation has been followed rigidly. It is expected that future work with the bomb will make possible more thorough investigations, particularly from the standpoint of pressure reduction by means of added chemicals. From the data gathered, the following conclusions have been reached: (1) Materials of the type represented by Wyoming bentonite are capable of producing pressures of considerable magnitude when confined during hydration. (2) Although the data on this point are not conclusive, it is thought that the nature of the exchangeable bases present will largely determine the swelling-pressure characteristic of a clay material. (3) A study of existing information regarding the increase of thickness and charge of the outer layer of the micelle as influenced by added electrolytes may provide a means for predicting relative maximum pressures attainable in the apparatus described. Additional experimental work will be of interest concerning such predictions. (4) In the early states of hydration, the swelling process follows a relationship of the type:

$$P = KT^n.$$

A. H. N.

351.* Adjustability and Interchangeability Feature Rig Substructure. J. C. Albright. *Oil Wkly*, 16.11.42, **107** (11), 45.—The substructure is made of casing and line pipe all of three identical sections to facilitate interchangeability. The three identical sections are made with pipe, the vertical sections of which require reasonably large-diameter pipe in pieces about $4\frac{1}{2}$ ft. long, cut squarely on one end for welding into the channel of the channel iron, which can be any length desired. Diagonal braces are

attached at an angle of 45° to the channel iron and the vertical riser, to obtain the required stiffness to resist vibration and strain of supporting heavy machinery in motion. This 8-in. riser is equipped with a number of 1¼-in. holes drilled on 5-in. centres squarely through both walls. To provide equal interchangeability, the first riser made was used as a pattern for the remaining units, so that the distance from the channel upwards to the first hole would be exact. The overall length of the riser is not so important as the spacing of the holes, since the upper end comes in contact with no other section, and that end can be left with threads or cut plain. Rough edges are eliminated.

Horizontal members on which the skid-frames of the engines and draw-works are placed, after the substructure is completed at the location, are made of three sections of pipe slightly smaller than the 8-in. vertical risers. Legs welded to the long horizontal supporting members are placed so that the skid-frames of the engines and draw-works rest directly above the vertical supports with the channel-iron footing on timber mats. These legs, one on each end of the horizontal pipe, have drilled holes of the same size as those which are placed in the vertical risers, but on closer centres, so that a relative fine adjustment in height can be made by matching certain holes in the inserted pieces and the vertical risers. Ribs welded to the outer surface of the insert pipe walls have sufficient thickness to provide a close fit between the inserts and the vertical risers, so that sufficient rigidity is obtained to eliminate side sway. Ribs have been found to serve better than a squeeze-fit pipe, since the bearing surfaces are smaller, and when the ribs are greased, inserting and removing the sections should not be difficult. The paper is illustrated. A. H. N.

352.* A Review of Recent Advances in Drilling-Mud Control. P. E. Chaney. *Oil Wkly*, 23.11.42, **107** (12), 25. *Paper Presented before American Petroleum Institute.*—A general view of the colloidal chemistry of clays and shales is presented as a theoretical background for the explanation of the various mud problems, and for the chemical treatments used in their correction. Each of the common mud problems is discussed separately, and an attempt is made to provide a method of diagnosing the cause of trouble from changes in the physical properties of the mud. Following this diagnosis, one or more methods of treatment for correction of the trouble are described, and the theoretical explanation for the action of the corrective treatment is presented whenever possible. A table showing the combinations of mud properties, or "symptoms" associated with each type of trouble, together with an outline of the corrective treatment, is presented as an aid in deciding rapidly on the cause of trouble, and in selecting the proper treatment. Two of these are reproduced as illustrations. Rock salt or salt-water flow: symptoms, (1) rapid increase in salt content of mud; (2) first effect is increased gel rate and viscosity; after several hours, or perhaps a day, viscosity drops below normal; (3) water loss increases rapidly; (4) in case of salt-water flow, mud continues to flow after pumps have been shut down. Chemical treatment: (1) In case of salt-water flow, increase mud weight as rapidly as possible until shut off is obtained, but watch closely for loss of mud to the formation, and stop weight increase if this occurs (even though some flow of water continues) until mud loss is stopped by addition of plastering agents. (2) In extreme cases, pull up in casing to condition mud, as the danger of stuck drill-pipe is serious when salt water is encountered. (3) Add large quantities of highly colloidal clay, preferably hydrated in fresh water before addition to the mud. (4) Copious additions of Quebracho are sometimes helpful in reducing "salt-water gel." (5) In severe cases, substitute organic colloids for clay in mud.

Heaving-shale troubles are treated as follows. A. Bentonic heaving shale: symptoms, (1) increase in mud viscosity and gel strength; (2) reduction in water loss and cake thickness; (3) tight places in hole. Chemical treatment: (1) Reduce water loss to lowest possible value. (2) Reduce mud *p*H to 7·2–7·6 by use of pyrophosphate. (3) Low *p*H muds tend to have very low gel strength. Do not reduce *p*H low enough to prevent suspension of weighting material and cuttings. (4) Keep mud viscosity and gel strength as low as possible to prevent swabbing. (5) Use sodium-silicate mud in very severe cases. B. Gas-bearing heaving shale: symptoms, (1) sour-gas odour at shale shaker; (2) little increase in viscosity unless bentonitic shale is also present; (3) tight places in hole. Chemical treatment: (1) Reduce water loss of mud. (2) Increase mud weight until difficulty is stopped or until loss of mud to forma-

tion begins. C. Plastic-flow heaving shale: symptoms, (1) large slabs of shale circulated out of hole; (2) shale may flow into hole to a height of a hundred or more feet on removal of drill-pipe; (3) stuck drill-pipe or tight places in hole; (4) usually found on highest part of structure. Chemical treatment: Same as for "B."

The paper deals with practically all the usual troubles. A. H. N.

353.* Cleaning Problems of the Oil-Fields. R. W. Mitchell. *Oil Wkly*, 30.11.42, **107** (13), 24.—The desirable factors to be considered in a cleaner are: It should be safe to handle and to use from the workers' viewpoint. It should also be safe to metals and materials of construction. Both the cleaner and cleaning method should be as simple as possible, with minimum dependence on technical supervision. The method and material should give speedy results. The cost of cleaning from the overall point of view should be kept as low as possible. Adequate cleaning routines almost invariably lead to longer service life of equipment and apparatus, but the investment has to pay dividends in order to justify itself. Hence final cleaning results obtained at such high costs that the benefits accruing therefrom cannot offset cleaning expenses are of no real value.

The clinging, greasy, oily dirt of derricks and derrick floors is hard to remove effectively and economically. Yet cleaning is necessary, not only for ensuring safe operating conditions, but also to prepare for protective painting whenever required. A new emulsifiable solvent cleaner recommended for this operation is sold as a concentrate, mixed on the job with kerosine or safety solvent, one part cleaner to eight parts solvent to make the cleaning solution. Derricks and derrick floors are readily cleaned with this solution, without need for steam or any source of heat. The cold mixture is sprayed on all surfaces to be cleaned, using a portable spraying tank with suitable nozzle. It is then allowed to soak in for about 15 min., after which all surfaces thus treated are flushed off with cold water under pressure. This completes the cleaning operation. No scrubbing is necessaty in 90% of the jobs.

Where dirt accumulations are heavy and of long standing, the initial treatment with the cleaner will remove most of the dirt, but it may be necessary to repeat the treatment, accompanied with scoring or scratching of thick deposits during the soaking-in period, to ensure speedier penetration of the cleaner. More than two applications are rarely necessary—and in fact on most derricks the single treatment is completely satisfactory. This method of cleaning gives very clean surfaces with a minimum expenditure of time and labour, and they can be painted when dry with no further cleaning treatment. In addition to the convenience and economy of working perfectly in cold solution without need for heat, steam, or steam-guns, the solution itself is non-poisonous, non-flammable at ordinary temperatures, and completely harmless not only to the human skin, but also to all metals and other materials of construction.

The cleaning of several important parts of an oil-field equipment is discussed in detail under separate headings. Finally the cleaning of the worker's hands is discussed. The most effective hand-cleaner is one that contains a properly balanced alkaline cleaning material and suitably graded and selected pumice. When the right degree of alkalinity is provided, the pumice works as an effective scouring agent to remove the embedded dirt particles which are unaffected by ordinary soaps. Sand and other harsh abrasives must be avoided, and at the same time too mild a scouring agent, such as corn meal, should not be used for oil-field hand-washing, since such are not strong enough to remove the kinds of dirts encountered. On many other industrial hand-cleaning operations, the vegetable-type scouring agent is completely satisfactory. A. H. N.

354.* Shallow Wells to be Drilled Without Water Casing-Strings. Anon. *Oil Wkly*, 30.11.42, **107** (13), 36–38.—Complete operating drawings, plans, engineering specifications, and full procedural directions covering methods for drilling of wells with a contemplated saving of about 85% in steel have been released to the oil-producers of California. The procedure will be tried out immediately on six wells in the Wilmington field of California, and it is understood that two large companies operating in Texas also plan to test it. The proposal is not looked upon as a cure-all, as it will probably work successfully in only a portion of the drilling operations. It will be

tried on shallow wells, and it is in this classification that it has probably its best chance of success. Diagrams explaining the scheme are given.

The cost of drilling a 3000-ft. well in California by the new procedure is estimated not to exceed $12,500, compared to a cost of $35,000 for a 3000-ft. well three years ago. A year ago, Continental Development Corporation drilled seven wells in the Wilmington field at a cost of $20,000 each, which then appeared to be a record low cost for such wells in this area. A. H. N.

355.* Drilling Fluid Technology. Part 2. L. C. Uren. *Petrol. Engr*, November 1942, **14** (2), 43.—In this second part of the paper the function of the mud as a heat absorber and lubricant for the drill-pipe is discussed. The following sections deal with the physical properties of drilling fluids, density, viscosity and colloidal properties, hydrogen ionization value (pH), thixotropic properties, sand and salt content, and with mud-control laboratories. These studies are followed by discussions on the constituents of muds and drilling fluids, dealing with clays, weighting materials, chemical reagents, and special oil-base fluids. The paper ends with a discussion on possibilities of future research. Little has yet been done in exploring the factors that control the efficiency of drilling fluid in its function of lifting drill cuttings. There would be fewer cases of " frozen " drill-pipe if we had a better understanding of the conditions that influence the lifting capacity of the circulating fluid. There is little information of bottom-hole temperatures in drilling wells and the influence of rate of circulation and mud properties on control of such temperatures. More should be learned of the drilling-fluid properties that promote " gas cutting," and better methods of separating entrained gas from gas-cut muds should be devised. There is opportunity for a broad study of oil-base muds, of methods of developing desirable properties in drilling fluids of this type, and of controlling these properties to meet changing conditions. The properties of oil-water clay mixtures is an almost virgin field.

Better methods of quickly evaluating clays for use in drilling fluids should be devised. Is the rate of hydration a significant index in this connection ? How may one determine the active colloidal content of a clay or drilling fluid ? Of what significance is the size-distribution of clay particles, and can some simple test for determining this be devised ? There is much to be learned in the realm of chemical control of drilling-fluid properties. Certain types of gums and resins produce interesting effects. More positive ways of dealing with saline-water contamination of drilling fluids must be developed. Methods of adapting the qualities of the mud to the peculiarities of the formation in which the drill is working—in "heaving shale ", for example—present definite possibilities. Successful methods of selectively removing clay sheaths from oil-wet and water-wet formations would be of great value. Tests and instruments should also be standardized. A. H. N.

356.* Modern Technique in Oil-Well Cementing. P. E. Hilton. *Oil Gas J.*, 3.12.42, **41** (30), 57. *Paper Presented before American Petroleum Institute.*—To place a cement plug opposite an oil-sand so that a water shut-off job is effected, a tail pipe, made of drillable metal, is run in on the bottom of the float or guide-shoe. A float-shoe with or without side ports may be used. When a float-shoe without side ports is used, all the cement is discharged through ports in the bottom of the tail pipe. In the case of a float-shoe having side ports, the cement is discharged simultaneously through the shoe and the bottom of the tail pipe. After cement sets, the shoe is drilled out with the cement plug to a short distance below the shoe for a water shut-off test, the remainder of the plug sealing off the productive zone during the procedure. With a satisfactory cement job assured the rest of the plug and tail pipe are drilled out. It is considered good practice to run a casing scraper between the bit and drill-collar to remove the sheath of cement left by the bit on the casing wall. A clean wall assures positive grip for slips and a smooth surface against which the packing member of testers and similar devises can seal, and prevents cementing tools, which are normally run with close clearances, from hanging up.

The procedure of running and cementing a blank liner in one operation involved the use of a float-shoe having side ports and left-hand square threads (positioned in an upper extension of the valve cage), a square, left-hand threaded sub which screws into the left-hand threads in the shoe, and a circulation or expansion joint, made up on the bottom of the running-in string, which may be either tubing or drill-pipe.

Cementing of the liner, which is run in on the bottom of the string, is performed in the usual manner, after which the running-in string is lowered a few inches, which telescopes the circulation joint and takes the strain off the sub. The running-in string is then turned to the right, which disconnects the left-hand threads, and raised several feet, so that any excess cement which may have come over the top of the liner can be back-scuttled. It then can be removed from the hole, leaving the liner cemented in place with the inside clean and ready for gun perforating.

Cementing liners with perforations below and blank above and a liner off bottom is accomplished by variants of this procedure. Multiple-stage cementing is also discussed. A. H. N.

357.* Drilling-Rig Functions Logged by Automatic Instruments. H. F. Simons. *Oil Gas J.*, 10.12.42, **41** (31), 41–43.—The drilling industry is in a transition stage from having practically no instruments to one of complete logging of all the primary functions. The objective is to record the information which makes possible the saving of time and money. This article describes the automatic logging of thirteen factors affecting drilling operations. These include the weight on the bit, revolutions/minute, torque on the drill-stem, mud pressure, rate of penetration, the level of the mud in the pit, the time required to circulate the fluid from the bottom of the hole to the surface, the oil and gas content of the mud, the *p*H, conductivity, viscosity, and specific gravity. The trailer housing the unit also includes equipment for other mud tests and core-analysis work.

The arrangement used is unique in that standard rig instruments are connected into the recording instrument. In other words, the regular weight indicator used at the rig is not replaced, but its reading at specified time intervals is recorded. The same is true of the pump pressure, torque and rotary speed, and the rate of penetration. Special instruments were developed for the automatic recording of viscosity and specific gravity of the mud and the delay time (time of circulation of the mud-stream). The torque is obtained from steam pressure in the engine manifold, the revolutions/minute of the rotary from a tachometer, and pump pressure is obtained from the mud-pump pressure gauge, but a stroke counter is to be added, rate of penetration is recorded by the selsyn motor method, the gas percentage in the mud is taken from a sample run into the trailer, viscosity of the mud from an automatic viscosimeter, specific gravity from an automatic and continuous weighing device, and the *p*H, oil content, and conductivity of the mud are obtained from a small sample stream.

All the data are recorded on two Micromax instruments. The one instrument records rate of penetration, weight, revolutions/minute, torque, pump pressure, and depth of fluid in the pit. The other instrument records the mud conditions, including percentage of gas, parts/million of oil, *p*H, conductivity, viscosity, specific gravity, and delay time. The instruments are driven by current from a small generator direct-driven by a small engine. The travelling chart is the usual ten divisions to the inch, the vertical scale being time, and the horizontal scale being required units for measuring each particular function. A complete recording cycle is made each 2 min. by the instruments. The travelling pen makes a dot on the chart, showing the reading of the instrument for determining one value, and then moves to another position for recording a different factor. On arriving at its new position, it is allowed 20 sec. to assume a stationary position. After this time delay a mark is made, and it moves to the proper position for recording the next factor.

After it has recorded all six or seven of the various functions, it is allowed 40 secs. in which to return to the original starting-place and repeat the cycle. Typical charts are studied and the significance of the tests is explained. A. H. N.

Production.

358.* Collecting and Examining Subsurface Samples of Petroleum. P. Grandone and A. B. Cook. *U.S. Dept. of the Interior, Bur. Mines Technical Paper*, 629, 1941.—The Bureau of Mines has developed a specialized technique for obtaining samples of petroleum under pressure from the bottom of wells, and for subsequent laboratory examination of these samples. This paper discusses the various factors which affect subsurface-oil samples prior to and during sampling. It also embodies a description

of a self-closing subsurface-oil sampler designed to trap the liquid phase of the well-fluid as it exists at the sampling point in the well and to retain the fluid intact until it can be transferred to other apparatus for laboratory examination. Physical properties of subsurface oil are considered, and laboratory methods employed for examining samples are described in detail. Specifically it is stated that the following data are desired by engineers in solving the various problems which arise in the production of petroleum from natural reservoirs: saturation pressure of the reservoir oil; compressibility of the liquid phase at reservoir temperature; total quantity of gas dissolved in different oils at different pressures and temperatures; quantity of gas liberated from solution in oils on decrease of pressure; contraction of liquid resulting from liberation of gas from solution in oils or on reduction in temperature; density and specific volume of the gas-saturated liquids; and pressure–volume relationships of the oil–gas mixtures.

At the time of sampling, auxiliary data relative to the well should be recorded. These include the name, depth, and thickness of the producing formation; sampling depth; oil-producing rate; producing gas/oil ratio; static and flowing pressures and temperatures at the sampling point; well-head blowing pressure; separator pressure and temperature.

Three definite procedures are available for the examination of subsurface-oil samples. These are: differential gas liberation; flash-gas liberation; and determination of pressure–volume relationship. Usually data obtained by the flash-liberation procedure are more applicable than differential-gas liberation data to the physical changes which take place in the gas–oil mixture as it is produced through the flow-string under changing conditions of pressure and temperature. Data from the differential procedure, however, probably represent more closely the physical changes which take place in the rsservoir oil remaining in the formation as depletion progresses. Determination of pressure–volume relationship on a sample of subsurface oil provides data for computing the energy available per unit weight of fluid as it undergoes pressure, volume, and temperature changes. H. B. M.

359. Steady Flow in the Transition Length of a Straight Tube. H. L. Langhaar. *J. Appl. Mech.*, June 1942, **9** (2), A-55–A-58.—By means of a linearizing approximation, the Navier–Stokes equations are solved for the case of steady flow in the transition length of a straight tube. The family of velocity profiles is defined by bessel functions, and the parameter of this family is tabulated against the axial co-ordinate in a dimensional form. Hence, the length of transition is obtained. The curves give a comparison of the author's calculations of the velocity field with those of other investigators, and with the experimental data of Nikuradse. The pressure function is derived from the computed velocity field by means of the energy equation, and the pressure drop in the transition length is defined by a dimensionless constant, m, which is computed to be 2·28. A discussion of this constant is given in the conclusions. It is to be noted that in viscometry the constant used for the kinetic energy correction, m, is half this value, due to incorporating in it the $\frac{1}{2}$ of the energy equation $KE = \frac{1}{2}\rho v^2$.

An interesting result is that the inlet length—that is, when the axial velocity approaches the theoretical value of twice the mean, actually 1·98 the mean—is 0·23 R number of radii is attained, where R is Reynolds number. Nikuradse's data appear to confirm these calculations. A. H. N.

360. Graphical Solution of Fluid-Friction Problems. E. S. Dennison. *J. Appl. Mech.*, June 1942, **9** (2), A-82–A-84.—It is customary to present fluid-friction data in the form of a diagram to log scale in which friction coefficient appears as a function of Reynolds number. Such data are widely applicable to physical circumstances other than those which pertained to the original experiments. The present paper describes a graphical procedure for utilizing data of this character, where analytical methods are not practicable, and resort is made to trial-and-error methods. Similar methods to that described may be found useful in other fields than that of fluid-friction, provided the experimental data are capable of being represented in non-dimensional form.

The paper deals specifically with the case of the fall of spheres in fluids and with the ordinary pipe-flow problem; but the method is general to all similar problems. The value of the method lies in that a direct solution is possible for problems where the

factor sought is included on both ordinates, such as the velocity or the diameter in pipe-flow, where these factors enter both the friction factor and the Reynolds number. Both the derivation and illustration of the analyses are given. A. H. N.

361.* Influence of Extraction Methods on Ultimate Recovery. S. F. Shaw. *Oil Wkly*, 2.11.42, **107** (9), 28.—The paper is a comprehensive and balanced review of theories and facts about ultimate recovery of petroleum from sands, and should be read *in extenso* to obtain its full value. Spacing of wells is discussed at length with the conclusion that, economics being first considered and found favourable, close spacing would result in greater recovery ultimately than wide spacing. The statement is supported by much data. For instance, the Turner Valley field, Canada, with a very tight reservoir, is one in which spacing has been on basis of 40 acres/well. The results to date seem to the writer to indicate that the yield will be perhaps 50% of what would have been the recovery had the spacing been on a basis of one well to 10 acres. However, with the prevailing price for oil and with cost of drilling amounting to between $150,000 and $200,000/well, it would not be profitable to drill four wells to double the recovery that appears likely to be obtained from one well. In this connection it will be interesting to observe the results obtained later in such fields as Wasson, Slaughter, Magnolia, and other similar limestone fields which have been developed on basis of 40 acres to the well.

The main conclusions of this long paper are: (1) Economics in the production of oil require greater consideration than ultimate recovery. (2) Ultimate recovery in many fields is increased by close spacing and production at maximum practicable capacity. It is possible that in nearly all oil-fields this conclusion may apply, but, if correct, it can become evident only in the course of time. (3) Acidizing, shooting, and completing wells with large casing aid in enabling wells to be produced at high capacity. (4) More energy in gas associated with the oil is available for moving oil through the sand from a given quantity of gas when expanding through a given range of lower pressures, that when expanding through a given range of high pressures. (5) Secondary-recovery methods are very important in increasing the recovery of oil where primary methods have not resulted in high-percentage recovery. When primary methods have resulted in high ultimate recovery it is a question as to whether secondary methods are economically applicable. (6) Secondary methods of artificial water-flooding seem to yield higher ultimate recovery when production is at a high rate. If this is a correct conclusion, it would appear as if natural flood with high-capacity production would yield higher ultimate recovery than when production is at a low rate.

The paper is well illustrated with tables and a graph, and twenty-nine selected references are appended. A. H. N.

362.* Many Avoidable Production-Equipment Failures Due to Field Abuse and Neglect. Anon. *Oil Wkly*, 9.11.42, **107** (10), 46.—The paper details various methods for maintaining equipment for a long time, in particular, stressing proper lubrication. A film of lubricant of sufficient strength to withstand localized contact pressure must be provided at all points of moving contact to prevent wear. When speeds are high, contacts are usually of short duration and loads are light, requiring the selection of a light-bodied lubricating oil. When speeds are low, contact time is longer and loads are heavier, requiring a comparatively heavy-bodied oil for proper lubrication. When loads are exceedingly high/unit of contact surface, extreme pressure lubricants are best suited for minimizing wear. In all cases it is advisable to use only high-grade lubricants.

Because it is difficult to keep containers clean on a drilling well or an oil lease, all oils and greases should be supplied in 4-, 5- or 6-quart sealed containers. This is particularly advisable in the case of all greases and oils that must be used in force-feed lubricators. Temperature affects the viscosity and lubricating properties of mineral oils, necessitating the use of different types of oil in summer and winter. At atmospheric temperatures below 55° F. an oil of lower viscosity should be used than is ordinarily recommended for atmospheric temperatures above 55° F. The maximum oil temperature at which standard lubricating oil should be used for bearing surfaces is 180° F. Particular care in the selection of lubricating oil is essential in the use of the many machines where the same oil is used for various parts, such as bearing,

slides, and gears. If an oil of high viscosity and high pour test is used in such a machine at low atmospheric operating temperatures, the oil will not flow readily and bearing failures may result. Methods of applying the lubricants are detailed.

The paper further deals with starting batteries, enclosures for equipment, and methods of rebuilding equipment or salvaging it. A. H. N.

363.* Maintenance Department Features Many New Tools and Efficient Techniques. G. M. Wilson. *Oil Wkly*, 9.11.42, **107** (10), 51–60.—The activities of this department come in contact with nearly every phase of the producing and drilling divisions of the company, and though there is, of necessity, a certain amount of overlapping, reconditioning work is performed in at least five major subdivisions of that department. These are: (1) valve and fitting shop, where all types and sizes of valves, fittings, and rotary chain are overhauled, as well as metal spraying and some small lathe work; (2) instrument and meter shop, where all kinds of gauges, recording meters, regulators, drilling instruments, etc., are repaired and rebuilt; (3) machine shop, which handles the repair and maintenance of larger equipment, such as pump cylinder reboring, engines, clutches, and similar heavy equipment; (4) tubular-goods handling section, which has developed some very practical measures in the salvaging and extension of life of such materials; and (5) system of records which facilitates inter-departmental "buying" and "selling" and keeps a running inventory of all equipment that comes through these departments. The various subdivisions are described in detail, the valve section being given particular attention.

An interesting section is the metal-spray rebuilding section. The operation, briefly, involves the forceful spraying of atomized molten metal on to the previously prepared bonding surface of the object being built up. Ordinarily, the object—in this case, a gas-engine piston—is chucked in a lathe, and the gun is mounted on or beside the tool-mount where it can be made to travel slowly back and forth, gradually building up the surface of the parent metal. Of prime importance—and the success or failure of the job depends on it—is the proper preparation of the parent metal surface. This involves taking a very coarse, rough cut on the surface, using a tool that literally tears the metal off, leaving a series of rough, jagged ridges and grooves. Since the bond of metal spray is a mechanical one, the jagged surfaces allow the impinging metal particles to take a firm grip on the base metal. After the surface has been built up sufficiently oversize, it is ground down with a power grinder, also mounted so that the tool-feed will carry it back and forth across the surface.

A steel plug is forced into the skirt-end of the piston to give strength and "body" to the latter. This plug should extend beyond the skirt-end far enough to permit the lathe jaws to take a full grip on it and allow sufficient clearance between the face-plate and gun when the latter gets to that end. This extension also keeps the piston skirt away from the face-plate so metal spray will not be so likely to get on to the face-plate or the dogs. A. H. N.

364.* Simple Preventive Maintenance Rules Prolong Sucker-Rod Life. G. M. Wilson. *Oil Wkly*, 9.11.42, **107** (10), 113.—When it is realized that an average string of sucker-rods may be subjected to loads ranging from 10,000 to 30,000 lb., and suffer as many as 15,000 to 30,000 reversals of motion/24 hr. day, it is apparent that the much-neglected sucker-rod really has a difficult job to perform. With a small nick or scratch already established in one of the rods, it is easy to see how a full break can soon develop when the string is being subjected to a round-the-clock series of alternate stretching and contracting under stress of the well load. When this load varies or becomes more severe due to a gas-lock or pumping-off conditions causing frequent pounding in the strokes, final parting of the rods at this zone of weakness will be materially hastened.

Wells which are not provided with derricks offer one of the best opportunities for rods to become damaged. On such wells the rods usually have to be laid down on the ground or some makeshift supporting blocks, the latter quite commonly being only several short pieces laid at infrequent intervals along the ground. Rods lying thus along the ground, particularly if the well is down for a prolonged time, are an invitation to trouble. Dirt, abrasives, use of hammers, etc., are added sources of trouble. The use of racks, proper haulage, and of protectors is urged, together with the keeping of records. One of the simplest and least expensive means of overcoming

such problems, which arise every day, particularly in the larger companies, consists in the use of a tagging system. Each crew foreman carries a quantity of two-section, perforated tags, on each section of which he jots down, in places provided for such data, the pertinent facts relating to that particular rod which he is laying down, and which he feels warrants further checking by the salvage or warehouse department. The upper half of the tag is then removed and tied to the rod before leaving the well. The lower half is retained and later turned in at the office at the time he makes out his daily work report.

For legibility, tags should not be less than about 3 in. wide and 6 in. long, being perforated in the middle to give two cards 3 by 3 in. when torn in half. Representative of the instruction headings which should be printed on each side of the two halves include: (1) The serial number (same number on each half of tag.) (2) Well number and lease. (3) Item reported. (4) Where taken if removed from well premises. (5) Why discarded or laid down. (6) Crew foreman's signature and crew number.

A. H. N.

365.* Co-ordination of Conservation Practices in the Various States. E. G. Dahlgren, *Oil Gas J.*, 12.11.42, **41** (27), 118. *Paper Presented before American Petroleum Institute.*—This paper discusses the co-ordinating activities of the Interstate Oil Compact Commission in the conservation of oil and gas in the various States. The work of the various compact committees is described and the conservation policies and administrative activities in the various oil producing States are summarized.

The legal committee of the Interstate Oil Compact Commission has been doing some outstanding work during the past year. At the 19th December, 1941, meeting of the Compact Commission in Oklahoma City, the legal committee adopted the programme as follows: (1) A study of the suggested model conservation law for the purpose of making any necessary amendments and corrections. (2) A study of the legal phases of repressuring and recycling. (3) Preparation and publication of synopses of all the statutes of the various oil-producing States. (4) A study of the relationship between the Federal Government and the States concerning the legal aspects of oil and gas conservation. (5) The preparation of a skeleton statute that might be advisable in non-producing States or in States with small production.

The paper deals separately with the conservation laws and practices of each State, including those which are only potential producers. A. H. N.

366.* Present Allocation Practices. D. R. McKeithan. *Oil Gas J.*, 12.11.42, **41** (27), 154. *Paper Presented before American Petroleum Institute.*—The development of allocation methods in the various oil-producing States is reviewed and analyzed; also a brief description of the administration and mechanism of the systems employed is presented. Conclusions reached therefrom are: (1) The oil industry is operated primarily on a competitive basis, and this factor adds to the complexity of the attainment of maximum efficiency in conservation, and allocation is extremely difficult. (2) Systems of control in the various States are geared to meet local operating conditions, as well as background and temperament of the people, in conformity with American standards of localized governments. (3) The actual mechanics of allocation used in the various States differ greatly and, further, it appears that one basic law or one rigid formula cannot be applied reasonably to all the varied conditions.

Vast strides towards general improvement have been made in recent years; however, there is still room for considerable betterment; and the "Standards of Allocation of Oil Production Within Pools and Among Pools," as set out in the report of the American Petroleum Institute's Special Study Committee on Well Spacing and Allocation of Production, should be of material assistance in further progress.

The paper deals with the chief oil-producing States individually under separate sections. A. H. N.

367.* Evaluation of Effective Displacement Pressures for Petroleum Oil–Water Silica Systems. F. C. Benner, C. G. Dodd, and F. E. Bartell. *Oil Gas J.*, 12.11.42, **41** (27), 199. *Paper Presented before American Petroleum Institute.*—The relative wettability of reservoir rock by crude petroleum oils and by water appears to constitute a more complex problem than has hitherto been generally assumed. Certain constituents of the

oils, even though present in minute amounts, may greatly influence the degree of wetting of the solid by the oil. In this investigation, an evaluation of relative wetting of reservoir rock by reservoir fluids has been attempted by the measurement of contact angles formed by petroleum oils and water on solid silica plates. Displacement pressures calculated from the contact-angle data were found to be in reasonable agreement with displacement pressures actually observed with the petroleum oils and water in packed-silica powders.

A study was made of both "advancing" and "receding" contact angles for a series of petroleum oils and water on silica. Advancing interfacial contact angles were found to vary over a wide range for the different systems studied, in some instances being less, and in others considerably greater, than 90°. Were the advancing angle alone to be used as a criterion of wetting, it would appear that in some systems water wets silica to a greater degree than does oil, but in other systems the converse is true. It was found that receding interfacial contact angles of the systems observed invariably assumed values of less than 90°. By this criterion, silica appeared to be better wetted by water than by oil. The advancing interfacial contact angle is believed to be a better indication of the hydrophilic or hydrophobic nature of the reservoir material containing the oil than is the receding angle.

The "hysteresis" effect was very pronounced in nearly all the systems studied. For most of the systems, the silica appears to have dual wetting characteristics, inasmuch as the receding contact angle is less than 90°; whereas the advancing contact angle is greater than 90°. The results from this research indicate that spontaneous displacement of oil from the underlying solid by water should occur only in those cases where both the advancing and the receding angles are less than 90°; that spontaneous displacement of water by oil should occur if both angles are greater than 90°; and that no spontaneous movement should occur where the two angles are on opposite sides of 90°.

It appears that, in the majority of cases, measurement of the contact angles formed on a silica plate between a petroleum oil and water will serve as a fairly reliable guide for the determination of the displacement tendencies of oil by water or of water by oil. The results obtained give fairly definite proof that crude petroleum oils contain constituents which become adsorbed on siliceous surfaces, causing those surfaces to assume hydrophobic properties. A. H. N.

368.* A Review of Multiple-Zone Well Completions. I. W. Alcorn and W. A. Alexander. *Oil Gas J.*, 12.11.42, **41** (27), 224. *Paper Presented before American Petroleum Institute.* —This paper presents representative data on multiple-zone completions which have been made in the several oil-producing regions of the United States. It is a joint effort of the topical committees on drilling and production practice, and constitutes a progress report on the subject. The desire of the oil industry to find ways and means of conserving steel in its drilling and production activities led to the decision to undertake this survey. An analysis of eighty multiple-zone completions indicates that an average per-well saving of 105 tons, or 4%, was realized in a multiple-zone completion, in comparison with two standard-well completions.

Available information indicates that the initial completion of wells in more than one zone can be accomplished successfully. Reliable data on the effectiveness of the method are at present limited to the earlier stages of multiple-zone production. Sufficient representative data on the later life (especially during the artificial-lift period) of multiple-zone wells are not yet available to permit drawing any definite conclusions as to the ultimate over-all practicability of the method. Existing conditions with respect to critical materials may reasonably be expected to result in an accelerated development of improved technique and more advanced methods of application. A. H. N.

369.* Conditioning Oil-Wells for Secondary Recovery. F. R. Cozzens. *Oil Wkly*, 16.11.42, **107** (11), 40.—The paper describes in brief certain treatments of wells. An oil-and-soap solution forms the basic treatment in Eastern areas, and the process is put into effect when the wells can no longer be pumped at a profit. While the pumping equipment is still intact, the reservoir or shot-hole at the bottom of a well is filled nearly to capacity with live oil into which has been stirred soap chips or granulated soap, in proportion of 5 lb. of soap to each barrel of oil. Six to ten

barrels of this solution are generally needed for each well. The lead line in the tubing is next connected with the gas-vent in the casing-head, and the well is circulated continuously for a period of 36–48 hr., then pumped dry. In the pumping out process, the oil-and-soap solution is conducted to a tank, where, after the residue has settled out, the oil is drawn off, mixed with about the same amount of soap as before, then again introduced into the well for another circulation. After two or three intermittent circulations of this kind, during which a careful observation is made as to type of residue pumped out, the large majority of wells show an increasing amount of live oil and gas. This is proof that the face of the reservoir has been washed clean and old channels opened.

Uses of paraffin solvents, acids, and shooting are briefly discussed. A. H. N.

370.* Tracer Gas Used to Check Repressuring Progress. H. F. Simons. *Oil Gas J.*, 19.11.42, **41** (28), 36.—The injection wells are equipped with packers so that the input into each horizon can be controlled. The producing wells are not equipped with packers, and produce through a common string of tubing. By injection of the tracer gas into one of the formations, the time for movement of the gas between the input and producing well can be determined. When it is desired to test a well, approximately 600 cu. ft. of 70% tracer gas is injected along with the repressure gas. This amounts to about 500 p.p.m. of the tracer in the injected gas. Gas from the producing well is then checked until evidences of the tracer begin to appear, build up, diminish, and finally disappear. The shortest time taken for the tracer to show up in the producing well was only a few months in one case, which showed there was evidently channelling of the formation. Injection in this particular case was discontinued temporarily.

The amount of tracer in the produced gas ranges from 3 p.p.m. to 175 p.p.m. Practically all of the injected tracer is recovered from the reservoir. The tracer gas used on these tests is manufactured in a small building, located at one of the compressor plants, at Loude. The tracer gas is generated from carbon dioxide and charcoal. The plant has a capacity of 600 cu. ft. of 70% pure tracer gas with two reactors in series operation/day at atmosphere. It is bottled at 900-lb. pressure. The procedure is for the test crew to take three bottles of gas out in the morning and three in the evening. These are connected to a bypass at the injection wells and the bottles are then purged of the tracer gas. The cost of the tracer gas is approximately 6 cents/cubic foot. A. H. N.

371.* Long-Stroke Pumping Unit Uses Mine-Hoist Principles. N. Williams. *Oil Gas J.*, 19.11.42, **41** (28), 50.—In the design of the unit, which, so far, is limited to working models, application is made of an old mine-hoisting principle, that of variable leverage as supplied by conoidal drums, to eliminate the unbalanced condition that exists at the end of the pumping stroke. Although the idea and use of conoidal drums for hoisting are far from new, this is the first time, it is claimed, that any attempt has been made to apply the principle for lifting fluid from beneath the earth's surface. Variable leverage of a conoidal drum is obtained through the changes in its effective radii. It is this that gives the constantly changing counterweight effect in the operation of the new pumping unit, and provides the unbalancing action at the completion of each stroke to start, or help start, the succeeding stroke while the prime mover is in process of acceleration. The change in radius which controls the length of stroke and speed can be governed by the size of the cable reels, and the thickness of the cable winding thereon, and by the steepness of the conical grooved drum. Elimination of the unbalanced condition at the end of a stroke makes practical the use of a simple prime mover in continuous frequent-reversing service.

Essentially the new unit includes an automatic reversing controller for a prime mover; a speed-reducing mechanism operated by a drive connection from the prime mover; an operating shaft from the speed reducer; the conical drum, secured on the shaft, and on which is wound the cable or chain operating the pump-rod, and the drum, on which is wound the line operating the counterweight. The arrangement of these elements is shown in accompanying drawings. Details of counterweight arrangements are given. Pumping strokes of from 50 to 75 ft. are considered feasible with the unit, the length of the stroke being limited only by the size of the drum and the height in the derrick of the blocks through which the pumping and counterweight

lines travel. With strokes of this length there is not only a substantial reduction in loss of energy due to rod stretch as contrasted with the loss incurred in the usual stroke lengths of from 2 to 6 ft., but also the less frequent stretching involved in the long strokes results in much reduced rod fatigue.

Other advantages claimed for the long-stroke unit are: (1) Elimination of gas-lock by winding the plunger out of the barrel to release the gas. (2) Elimination of paraffin from centre of tubing by rod-joints which will pass all points in the tubing. (3) Loosening of sanded plungers by a jar in the rod-line actuated by reversing the prime mover to produce the jarring action. (4) Reduction in cut oil and less disturbance of sand through the elimination of short, choppy strokes. (5) The unit can be equipped to shut down automatically when a well pumps off or starts to flow. (6) Slow rate of acceleration of the stroke reduces peak well weight. A. H. N.

372.* Progress in Reservoir Technology. Part 4. M. Muskat. *Petrol. Engr.* November 1942, **14** (2), 65.—Well spacing is the first item discussed in this part. It is argued that from a physical viewpoint there is no basis for preferring close to wide well spacing or vice versa. It is from the practical and financial standpoint that there is a basis for distinction. Even should there be a tendency for the economic ultimate recovery to increase somewhat with the well density, this in itself does not provide the answer to the well-spacing problem. For obviously it would be economically unsound to increase the well density if the increased production before abandonment would not pay for the cost of the additional wells. Indeed, it is only by balancing the added value of the production against the increased investment and operating costs that the true economic optimum well spacing may be determined. In particular, we must look for the maximum in the difference between the curve for the income from the oil recovered and the cost of the development and operation, each plotted as a function of the well spacing. In determining each of these, account must be taken of the effect of the well spacing on the life of the operations and the interest charges on the investment and discount rates for future profits. It is thus found that the curve for income from oil recovery rises rapidly at first and then quickly flattens out as the well density increases. On the other hand, the cost curve maintains an approximately linear rise throughout the whole range of practical spacing variations. The optimum spacing—that for maximum profit—is then the abscissa for maximum difference between the curves, or for equal slopes. For physical and cost constants of such magnitudes as are encountered in practice, this method leads to optimum spacings for gas-drive fields as are actually indicated by direct field experience—namely, 20–100 acres/well.

Proration is next discussed. From the technical standpoint, proration has had two major effects. First, as implied by the definition of the term, it has forced the operation of wells and fields at lower production rates than possible by wide open flow. Second, it has created the problems of proration formulæ, and allocation of production, which, in turn, have stimulated much of the progress already discussed. These two effects are detailed.

A brief study of conservation concludes the paper. A. H. N.

373.* Oil Recovery by Under-Pressuring. F. R. Cozzens. *Petrol. Engr*, November 1932, **14** (2), 72.—Under-pressuring begins after a secondary-recovery method has been in effect for some time. The method constitutes removing the false bottoms of certain of the intake wells, and lowering the air-induction tubing so that the extreme low sections of the sand will receive the repressuring medium. To confine the pressure, packers are usually run and set in the string immediately below the areas of sand that have been previously pressured. There is no methodical rule regarding the number of wells to be thus treated, but most operators use a ratio of one-third their intake wells, situated at various points over the field. When the estimated number of wells have been deepened and recompleted, air or gas is forced into them at full capacity, and as fast as the sand will take it. As pressure builds up, the pressure on the remaining input wells in the upper sand zones is gradually reduced until only sufficient pressure is maintained to push the oil to producing (open) wells. Pressure to the deepened wells, however, is continuous, and a built-up pressure of 300–500 lb. is necessary for best results.

An air-pressure increases in the base of the sand, the fluid content (oil, water, and

other drainage) expands and rises. The oil, being lighter, is first to enter the producing sand zones, and is later followed by water. A good percentage of oil is generally recovered before water becomes troublesome in the pumping wells, but even as water increases in volume, the operator still benefits. The rise of water in the sand floods the channelled-out portions and acts as an effective remedy for the former bypassing of air. The increasing water volume likewise has a tendency to release considerable oil from side margins of the sand, and to float oil from crevices and pockets that cannot be reached by air- or gas-pressure alone. Combined pressure (air or gas and water) from below keeps fluid always within the scope of producing wells throughout the entire life of the recovery project. A. H. N.

374.* Thermo-Siphon Heaters for Oil-Field Operations. H. Vance and E. G. Smith. *Petrol. Engr*, November 1942, **14** (2), 103.—The most common application of the thermo-siphon heater is in the flow-tank or gun-barrel for the purpose of breaking down emulsions. In a gun-barrel installation, where the oil to be heated is floating on top of a body of hot water, the area of contact is equal to the cross-sectional area of the tank containing the two liquids. Thus, we find that the diameter of the tank is the controlling factor, provided that the difference in temperature between the oil and the water is the same. In order to increase the surface of contact one may install in the ordinary gun-barrel what the writers have termed an emulsion pre-heater, which consists of coils very similar in design to steam-coils used in heating oil with steam. The oil from the well passes directly through these coils, which are in turn covered with hot water; then the oil is discharged through an enlarged pipe section into the body of the oil itself. This problem of surface contact is directly responsible for the low heat transfer possible in a small oil and gas separator.

Complete design data are presented and used in typical examples. A. H. N.

375.* Gun-Perforated Well Completions. B. C. Craft. *Petrol. Engr*, November 1942, **14** (2), 112.—The study was made to determine the optimum number of perforations/ft. of casing as a guide to engineers and operators. Theoretical work, based on Muskat's formulæ, is presented. Experiments showed the pressure loss resulting from the sand bridge over rectangular slots to be small, if the slot width used is equal to twice the grain size at the 10 per centile, but to increase as the slot width is reduced. Likewise, it is believed that the effect of bridging or filling of the perforations with sand would be small. Although the pressure loss, due to openings in the slots, has been found to be small compared with the convergence loss, it would be approximately twice as large as when the liner is set in open hole, due to the orifice effect of the perforations. If the total equivalent area of the perforations is twice that of the openings in the liner, this loss is one-fourth the liner loss; conversely, if this area is one-half, the pressure loss will be increased four times.

It is impossible to estimate how many of the gun perforations remain open. It is standard practice with some operators to run a rock-bit or mill past the perforations before going in the hole with the well-setting to prevent bullets that may have wedged in the side of the casing from tearing the screen and to remove the mud filter-cake over the perforations. Other perforations may be plugged with small pieces of cement and shale. Evidence of plugging has been obtained from an examination of screens removed from high gas–oil ratio wells. The screen-pipe either showed the effect of, or was cut through entirely by, the jetting action of sand particles flowing through the limited number of open perforations. Due to the high pressure losses resulting from convergence or crowding of the fluid at the perforations, the pressure loss due to the orifice effect of the perforations, the cost of reworking wells when the screen-pipe has become gas cut, and finally, due to the plugging of a number of the perforations, it seems safe to conclude that the combined area of the gun perforations/ft. of casing should be within the range of one and a half to twice that of the opening/ft. of screen-pipe. A. H. N.

376.* Prediction of the Shrinkage of Crude Oils. D. L. Katz. *Oil Wkly*, 30.11.42, **107** (13), 17–22. *Paper Presented before American Petroleum Institute.*—Recent information on the methods of computing the density of liquids containing dissolved gases makes possible more accurate calculation of phase behaviour under pressure for

crude-oil–natural-gas systems. This report covers several methods for predicting the shrinkage of a reservoir crude oil when such field data as reservoir pressure, reservoir temperature, solubility of gas in the oil, lease-tank crude-oil gravity, and gravity of the gas (air equals 1) are given for the reservoir under consideration. When all of these items are known, the method is straightforward and reliable; whereas if only solubility, crude-oil gravity, reservoir pressure, and reservoir temperature are known, the method becomes less reliable. For cases in which only crude-oil gravity, reservoir temperature, and reservoir pressure are available, even more approximate methods are presented. A rough method for prediction of the solubility of gas in the crude oil from saturation pressure and crude-oil gravity follows the shrinkage calculations.

The shrinkage calculations do not depend on the separation process—*i.e.*, flash or differential vaporization of the gas—because the properties of the resulting gas and liquid, as well as the quantity of gas liberated, compensate for any changes in the shrinkage value. A method of computing the density of crude oil saturated with natural gas has recently been presented. The method consists of computing the density of the liquid at 60° F. and 1 atmosphere of pressure by the use of additive volumes, and correcting the density from 60° F. and 1 atmosphere: first, to the pressure desired, and then to the desired temperature. The densities of all constituents heavier than ethane are taken as the normal density in grams/millimetre or pounds/cu. ft. of the pure constituent at 60° F. and its vapour pressure. For methane and ethane, it was necessary to devise an apparent density chart which gives the density of methane and of ethane as a function of the concentration (in weight per cent) in the liquid, and of the density of the constituents other than methane or ethane. In most cases the method will compute the density of the crude oil saturated with natural gas to about $\pm 2\%$.

The calculation of the density of a crude oil saturated with natural gas requires the analysis of the gas which is liberated when the crude oil is reduced in pressure, such as to atmospheric, together with the density of the remaining crude oil at the lower pressure. The quantity of gas liberated is added to the final crude oil, and the total volume of the crude oil saturated with this gas is computed at the saturation temperature and pressure. This volume minus that of the residual crude oil gives the shrinkage caused by vaporization.

The paper is well illustrated by tables and examples. A. H. N.

377.* Policies and Results of Water-Flooding in Kansas. P. Reed. *Oil Gas J.*, 3.12.42, **41** (30), 31.—Those attracted to water-flooding for the first time frequently under-estimate the time and expense usually consumed in selecting and acquiring producing properties suitable for water flooding. It is now widely recognized that in order to make a profit out of flooding at prevailing prices for crude oil, it is necessary to recover at least 3,000 brl./acre from sand with considerably more than 35% saturation. In order to do this with the 330-ft. and 440-ft. spacing patterns commonly used, operators have been looking for sand bodies at depths less than 700 ft. containing oil of well above 30° A.P.I. Operators have found these conditions met to a larger extent in South-eastern Kansas than in any other Mid-Continent area. There, the shoestring sands of fairly uniform and moderate permeability without the presence of a water-table are well suited to water-flooding.

In reviewing the first five years of water-flooding, it is seen that, following the initial influx in 1936 and 1937, there was a steady expansion in the application of this technique. However, it was somewhat retarded by difficulties in finding outlets for production. Last year and this year, due to war conditions, there has been a definite acceleration of the trend to water-flooding. Of the thirty-three projects of which records are available, only nine showing a substantial increase were producing more than 100 brl.

The typical successful water-flood property produced between 7 and 20 brl. from 80–160 acres before flooding. It has been developed for water-flooding according to a systematic plan which provides for adequate water-treating programme and progressive extension of water-flooding each year to parts of the property which had hitherto been unaffected by the drive. In this way the operating organization can be held together on a fairly permanent basis and the company can maintain production somewhere near the same levels from year to year. Although some operators favour

producing by flowing throughout the life of the property in order to save the expense of pumping, the general practice is to pump during the early life of a property, and flow during the last stages, when the oil–water ratio is greater than 1 to 10. By such a progressive programme it is possible to shift pumping equipment from flowing wells to wells in the newly flooded sections. Furthermore, this plan enables the company to profit by its experience so that more efficient methods may be applied as operations proceed. However, certain operators favour a policy of developing an entire property as rapidly as possible for water-flooding in order that oil may be recovered in a short period of operation with a minimum of overhead.

Details and certain features of special interest in various fields are discussed.

A. H. N.

378.* Raising Oil and Water from Oil-Wells. S. F. Shaw. *Oil Gas J.*, 10.12.42, **41** (31), 51.—A portion of this paper is cut by the Censor from *Journals* coming to England. In the remaining portion the combination air-lift plunger-pump method used in oil-fields is discussed. First trials were unsatisfactory, but a later method was not entirely so. In this method the compressed air was employed to drive the pump engine, and this air was exhausted into the pump column and used to lift the oil by air-lift from the pump to the surface. The use of compressed air to operate the pump was a distinct advantage in that it eliminated the need for a 6500-ft. string of sucker-rods, but the application of the compressed air to drive the pump and also to lift the oil to the surface met with difficulties, in that there was no effective means of controlling the supply delivered to the pump as distinguished from the supply of air required to perform the air-lift operations. In fact, no attention was paid to the air-lift phase of the lifting operation, and yet this was most important, since it involved lifting the oil from the pump to the surface, a distance of nearly 6500 ft. Improvements could perhaps have been made in the type of pumping engine employed, but the main difficulty lay in the improper and misunderstood method of applying the air-lift.

It is believed by the writer that this method of using the plunger pump driven by compressed air in combination with air-lift possesses considerable merit, and should find an important application on oil-field lifting operations, particularly in deep wells. After flowing, pressures in oil-wells decline to a low point, the consumption of gas/barrel of oil increases to an excessive point; also the quantity of oil entering the well is reduced by reason of the back pressure held against the sand face through the use of this excessive quantity of gas. Therefore, if an increased submergence can be artificially created for the air-lift and at the same time the back pressure at the sand face is reduced, there will be an increased production of oil, and a smaller quantity of compressed air required to lift the oil.

A. H. N.

Transport and Storage.

379.* Results of Corrosion Inhibitor Demonstrated in Products Line. S. S. Smith. *Oil Gas J.*, 24.9.42, **41** (30), 85.—The successful application of a corrosion inhibitor, developed by Dr. Wachter of Shell Development Co., to an 8-in. pipe operated by Shell Oil Co., is described. The inhibitor is very soluble in water, and a solution is injected continuously by means of a special device into the product stream at the pumping station. Concentrations of inhibitor in excess of 0·03% are required in the free water present to preclude corrosion, and the water must be maintained alkaline (*p*H value in excess of 7·5). To this end caustic soda was added to the injection solution. Care is also taken to maintain the line as water-free as possible. Control of injection may be obtained by testing inhibitor concentration of effluent water. Operations prior to injection had resulted in appreciable scale formation and reduction of line capacity. Charts presented show (1) line temperatures and line gradient; (2) inhibitor injection rate, inhibitor content of effluent water, scale removal, scraper usage, and line capacity (expressed as "*c*" factor by the modified Hazen and Williams formula) over a prolonged period of operation with inhibitor injection. In the early stages inhibitor injection rate was small but was later increased appreciably with a resulting immediate improvement in "*c*" factor and in scale removal.

Tentative conclusions reached from the accumulated data are:

(1) All effects in a long line are much slower than usually anticipated, and only a long-period collection of "c" factors and scale receipts is useful for analysis.

(2) Over-inhibition is necessary to improve "c" factors and to remove scale.

(3) Effluent inhibitor concentration is the index of effectiveness of inhibition.

(4) A products line can be cleaned and maintained clean by the use of this inhibitor, with only nominal scraping to move scale dislodged from the pipe into the stations.

(5) There is no danger to the line resulting from moderate over-inhibition to hasten scale removal. No difficulty has resulted in ordinary operation from the use of the inhibitor.

(6) An old scaled line with "c" factors under 130 will probably improve for a year under inhibition and will attain approximately original factors.

The inhibitor is now in general use on all products pipe-lines operated by Shell Oil Co. R. A. E.

380.* Mitigation of Underground Corrosion of Pipe-Lines. Anon. *Oil Gas J.*, 1.10.42, **41** (21), 37.—Information from a review prepared by the Bureau of Standards is presented. Well-drained areas should be selected for tank farms and other projects requiring buried tanks or containers.

Where choice is possible, right of way of pipe-lines should be selected so as to avoid swamps and corrosive soils. Where this is not possible, back-filling the trench with sand or other non-corrosive material, or even with lime, may be advisable. Other precautions recommended are careful tamping of soil around the lower half of the pipe, and avoidance of contact with rocks, sticks, or other solid materials. Corrosion tends to increase with the depth at which pipes are laid.

There is little difference in the rates of corrosion of commonly used ferrous pipe materials. Average results of the Bureau of Standards soil-corrosion tests indicate that wrought iron corroded slightly less, and cast iron slightly more, than Bessemer steel during the first twelve years of exposure, but the relative merits differ for different soil conditions.

Addition of nickel to steel is more effective than chromium, but corrosion is not greatly reduced until the percentages of these materials become sufficient to affect materially the cost of the alloy. An alloy containing 14% Si is very resistant to most soils, but hard to machine and brittle. The increased cost of the more resistant materials must be balanced against cost of leaks to decide whether their use is justifiable. For reasons enumerated, lead coatings have not been generally successful underground.

Some of the more important papers on cathodic protection have been summarized for distribution by the Bureau of Standards. Under some conditions protection of pipes by this method is less expensive than any other means of keeping them in service. Insulated coatings greatly reduce required current consumption, and although data on the life and effectiveness of coatings are meagre and conflicting, a reasonable evaluation of the economics of combined coating and cathodic protection should be possible.

Insulating joints, correctly installed at strategic points along a line, may be of much value in combating corrosion, and advice regarding installation is given. Uses and limitations of wooden and cement-asbestos pipes are described. R. A. E.

Cracking.

381. Patents on Cracking. W. J. Degnen. U.S.P. 2,305,569, 15.12.42. Appl. 15.4.38. High-boiling hydrocarbons are catalytically cracked by an endothermic reaction which involves contacting vapours of the hydrocarbons at high temperatures with a pulverulent cracking catalyst. The heated particles of the solid catalyst are dispersed in a heated vapour stream of the hydrocarbons. The dispersion is passed upwards through a cracking zone of relatively large cross-sectional area in which the velocity of the vapour component is sufficiently low to produce a cloud-like accumulation of catalyst particles. The cracked vaporous products are withdrawn from the upper part of the zone and catalyst particles contaminated with carbonaceous matter

are recovered. These particles are continuously passed to a regeneration zone, where carbonaceous contaminant is removed by combustion.

P. L. Veltman. U.S.P. 2,307,434, 5.1.43. Appl. 7.2.40. In cracking of a hydrocarbon oil, a stream of vaporized feed oil is introduced at a temperature between 800° and 1000° F. into a reaction zone containing a mass of solid, conversion catalyst in particle form. Heated feed-oil vapours are passed through the mass, while an absolute pressure is maintained in the catalyst zone within a relatively narrow range extending both below and above a predetermined mean pressure. The pressure in the reaction zone is subjected to substantially continuous fluctuation within this range, without interrupting the flow of hydrocarbon feed. Pressure is alternately increased and decreased, over a range of about 10–15 lb. Hydrocarbon products are finally discharged from the reaction zone.

K. K. Kearby. U.S.P. 2,307,795, 12.1.43. Appl. 14.12.38. In the catalytic conversion of hydrocarbon oils a bentonitic clay is used as catalyst. The bentonitic clay is pretreated in its raw state with dilute strong mineral acid to remove 50% of its original impurities. Regeneration of the clay is carried out in the absence of a substantial amount of water vapour. H. B. M.

Hydrogenation.

382. Patent on Hydrogenation. J. Turkevich. U.S.P. 2,307,715, 5.1.43. Appl. 29.8.40. Hydrocarbons are dehydrogenated by contacting them at a high temperature with a catalyst consisting essentially of an intimate mixture of chromic sulphide and chromic oxide. The mixture is prepared by heating chromic sulphate in a reducing atmosphere to effect reduction of the sulphate to a mixture of the sulphide and oxide. H. B. M.

Polymerization and Alkylation.

383. Patents on Polymerization and Alkylation. Anglo-Iranian Oil Co. E.P. 550,477, 11.1.43. Appl. 2.10.40. In a two-stage process for the production of high-octane-number gasoline, or a constituent thereof, from normally gaseous hydrocarbons boiling below 50° C., a hydrocarbon fraction, consisting of one or more alkanes, is subjected to isomerization at a pressure between 1 and 50 atmospheres and at a temperature between 250° and 600° C. Isomerization is carried out in the presence of a catalyst consisting of a metal oxide and/or a sulphide of Group 6 of the Periodic Table with the possible addition of metallic oxides or sulphides of Group 8. The *iso*-alkane produced is subjected, together with an alkene, to alkylation at moderate pressure and at a temperature between − 50° C. and + 100° C. in the presence of an alkylation catalyst. The alkylation product is distilled to yield liquid hydrocarbons having more than 6 carbon atoms.

E. T. Layng. U.S.P. 2,307,689, 5.1.43. Appl. 29.2.40. Olefinic hydrocarbons can be converted to higher-boiling hydrocarbons by contacting them at a high temperature with a catalytic contact material consisting of a plurality of porous granules of supporting material impregnated with the residue formed by heating a complex of ammonia and a metal pyrophosphate capable of reduction to a polymerization catalyst.

G. Egloff. U.S.P. 2,307,773, 12.1.43. Appl. 18.11.40. To convert paraffinic hydrocarbons into higher-molecular-weight paraffins the following procedure is adopted. A paraffin is fluorinated under conditions capable of producing a reaction mixture of alkyl fluoride and hydrogen fluoride. An *iso*paraffin is added to the mixture, which is then alkylated with the alkyl fluoride in the presence of hydrogen sulphide. H. B. M.

Refining and Refinery Plant.

384. Patents on Refining and Refinery Plant. C. W. Tyson. U.S.P. 2,305,046, 15.12.42. Appl. 11.12.40. Treatment of a feed mixture for the separation of vaporized oil constituents from unvaporized oil constituents at temperatures at which the un-

vaporized constituents will further decompose. The feed mixture is passed into a cyclone separator at a temperature at which no vaporization of the liquid will occur. The walls of the separator are cooled by means of water circulated in a jacket round the walls. Vaporized constituents are withdrawn overhead and unvaporized constituents are withdrawn as bottoms.

D. I. Ashworth. U.S.P. 2,305,464, 15.12.42. Appl. 21.11.39. To remove impurities from oil which contains water a flowing stream of the oil–water mixture is established and then heated to a temperature designed to coalesce the impurities and render them readily separable from the oil. During heating the stream is maintained under pressure not lower than that required to prevent substantial vaporization of water. The stream is cooled to a temperature below the flash-point of the oil, and during the cooling process substantially the same pressure is maintained as that applied during heating. Afterwards pressure is substantially reduced without atomization and water plus impurities are separated from the oil.

W. W. Reed. U.S.P. 2,306,843, 29.12.42. Appl. 25.7.41. In a process for the caustic scrubbing of a petroleum distillate oil a partly spent aqueous caustic reagent is introduced into the vapours of the distillate oil, and flows concurrently therewith to and through condensation. Caustic reagent and condensate oil are separated to form a body of reagent through which condensate oil passes upwards and collects. Spent caustic reagent is removed, and collected partly treated condensate oil is passed upwards through the interstices of a packing material submerged in a body of caustic reagent for final treatment. Finished oil is collected and removed and fresh caustic reagent is supplied to the top of the caustic reagent body. Partly spent caustic reagent is removed from the bottom to supply the necessary partly spent caustic first introduced into the oil vapours.

R. E. Burk. U.S.P. 2,306,933, 29.12.42. Appl. 11.8.39. Sulphur compounds are removed from petroleum by eliminating hydrogen sulphide and afterwards heating the petroleum and separating it into lighter and heavier products. The heavier portion is conditioned for the action of metal carbonyl by subjecting it under mercaptan-forming conditions at a temperature of 400° F. to an agent for converting non-mercaptan sulphur into mercaptans. The treated material is subjected to the action of metal carbonyl at a temperature between 300° and 650° F. Finally all unreacted metal carbonyl is removed.

L. L. Lovell, W. River, P. E. Malson, and L. F. Bouillion. U.S.P. 2,306,993, 29.12.42. Appl. 30.6.41. A process for desulphurizing a normally liquid hydrocarbon distillate containing organic sulphur compounds. The distillate is contacted with a liquid slurry of an agent consisting essentially of clay in a hydrocarbon carrier oil at a temperature above that required for flash vaporization of the distillate and below that of incipient cracking under the conditions of the process. The slurry is heated to a temperature between 585° F. and the incipient cracking temperature. H_2S is thus liberated, and distillate and H_2S can be separated in vapour form from the slurry. The oil has a specific dispersion not above 115 and a resin content of less than 3%. It is free from asphalts and substantially non-volatile at the temperature of heating. The clay is previously activated by treatment with an electrolyte-yielding compound of an inorganic poly-oxy acid radical.

R. W. Henry and J. V. Montgomery. U.S.P. 2,307,130, 5.1.43. Appl. 25.3.40. To dewax mineral oils the waxy oil is first mixed with a dewaxing solvent. The mixture is chilled to precipitate wax, and the wax-oil-solvent compound is passed to a separating zone comprising washing and refluxing sections at a point intermediate between these two sections. A stream of chilled wash solvent is passed through this separating zone from the inlet end of the washing section to the outlet end of the refluxing section. In the stream of chilled wash solvent the oil and solvent from the precipitated wax-oil-solvent mixture are selectively dissolved. Into the oil-solvent mixture at a point adjacent to the outlet of the refluxing section an inert gas is passed. The inert gas completely dissolves in the mixture, and causes additional wax precipitation as reflux wax which flows by gravity in a direction countercurrent to the flow of the solvent-oil mixture and is washed by it. Reflux wax and precipitated wax are combined at the intermediate point of the washing and refluxing zones.

The combined waxes flow by gravity in a direction countercurrent to the flow of chilled wash solvent, and are washed with progressively purer wash solvent. Washed waxes are removed at the chilled solvent inlet end of the washing section. The solvent-dewaxed oil-dissolved gas mixture is removed at the solvent outlet end of the refluxing section.

R. L. Betts. U.S.P. 2,307,873, 12.1.43. Appl. 30.11.40. High-quality petroleum resins having softening points in the range 100°–200° F., with absolute colour below 1000, are segregated from extremely high-melting-point, dark-coloured resins having softening points above 200 in the following manner. A petroleum oil containing natural resins is treated with a phenolic solvent to form a raffinate phase and a homogeneous solvent-extract phase. Sufficient water is added to the extract phase to bring the ratio of the phenolic component in the solvent to water contained in the extract phase within the approximate limits 90 : 10 to 70 : 30. The extract phase is separated from substances which are not homogeneously contained therein, and the extract is freed of solvent. The solvent-free extract is distilled under sufficient vacuum to prevent substantial decomposition. Finally a high-quality resin distillate is separated.

F. A. Ferguson. U.S.P. 2,308,163, 12.1.43. Appl. 27.12.39. In a process for concentrating sulphuric acid containing carbonaceous material, a pool of acid is established in a stripping zone, and sulphuric acid and hot gases are fed concurrently into this pool, below the surface thereof, and in close proximity to each other. In this way incoming acid contacts the hottest gas first, and thus converts carbonaceous material in the acid into granular form. H. B. M.

Chemistry and Physics of Petroleum.

385.* Photomicroscopy of Salt in Petroleum. L. F. Christianson and J. W. Horne. U.S. Dept. of the Interior. *Bur. Mines Technical Paper*, 638, 1942.—Until recently the composition of salts in or associated with petroleum has been determined by chemical methods, and the information gained in this way has been considered adequate for normal desalting operations. As pointed out in this report, however, the physical state and behaviour of the salts are important factors, and it is for this reason desirable that chemical analyses are supplemented with a knowledge of the physical form and mode of dispersion of these salts.

The report presents new data relative to the behaviour and type of emulsified brine droplets and to the natural physical structure and size of salt crystals found in petroleum. These data were obtained with the aid of a petrographic microscope, and observations were recorded and shown on photomicrographs. For the purposes of the investigation the physical state of salts of some of the oils being produced in the Mid-Continent area was studied. Initially, chemical analyses were made to determine the quantities of the predominating salts, and also to find the total quantity of water-soluble chlorides in the oils. Thereafter, photomicrographs were prepared to illustrate the variation in emulsions, the action of demulsifying agents, and the physical forms in which the salts crystallize from the demulsified oil.

It was found that the salt in the brine emulsion will ultimately precipitate as free or oil-coated microscopic crystals when the emulsion film has broken or when other conditions exist which permit the water to evaporate from the brine. It was concluded from these observations that it is better to make one complete dehydration of the emulsified oil at the time of treatment than to allow salt crystals opportunity to form from the partly demulsified brine.

Examination of various emulsions showed characteristic differences due to salt content, manner of producing the oil, size of droplets, and stability. Microscopical data revealed that the proper chemical destabilizer gave excellent results, but an improper chemical tended to create a very fine " tight " emulsion which might not be detected by the usual tests.

Careful study was made of the behaviour during refining of the salts in crude oils having a paraffin-intermediate base. Salts were examined and photographed in the crude oils before and after desalting, and in the refinery residual oils. Decomposition of the calcium and magnesium chlorides was found to be less in these oils than has been reported elsewhere. H. B. M.

386. Limits of Inflammability and Ignition Temperature of Ethyl Mercaptan in Air. G. W. Jones, R. E. Kennedy, and W. E. Miller. U.S. Bur. Mines. *Report of Investigations*, No. 3648, June 1942.—In many types of fuel gases and dangerous atmospheres ethyl mercaptan (CH_3CH_2SH) is used as an odorant to give warning of leakages of such gases into places where they might cause explosion or health hazards. By reason of its pungent smell, resembling that of onions, garlic, hydrogen sulphide, etc., ethyl mercaptan is particularly suitable for this purpose, and can be detected in very low concentrations. It is pointed out that because of its low boiling point (34·7° C.) and correspondingly high vapour pressure at ordinary temperatures, ethyl mercaptan on exposure to air gives off enough inflammable vapour to create a decided explosion hazard. Experiments have been conducted to determine the limits of its inflammability in air and its ignition temperature in both air and oxygen. Results of these experiments are recorded in this report.

It was found that ethyl mercaptan becomes inflammable in dry air when the concentration reaches 28·0% by volume. During investigations of the upper limit of inflammability "cool-flame propagation" was observed. The flames were similar to those encountered in ether–air mixtures in the upper limit range. In a completely dark room, a long, very pale-blue flame was observed. On the basis of fourteen tests, in which the concentration of ethyl mercaptan ranged from 2·70% to 19·00% by volume, the upper limit of inflammability was established at $18{\cdot}2 \pm 0{\cdot}2\%$ ethyl mercaptan, by volume, in air.

Minimum ignition temperatures of ethyl mercaptan were found to be 299° C. in air and 261° C. in oxygen. H. B. M.

387. Separation of Gas Mixtures by Thermal Diffusion. Anon. *J. Phys. Chem.*, 1942, **46** (7), 820.—On the basis of the kinetic theory, equations are given which enable the degree of separation to be calculated for a binary gas mixture under thermal diffusion conditions. These equations predict the effect of: the physical properties of the binary mixture components, the temperature gradient, the pressure, and the dimensions of the apparatus. To examine the validity of these equations a simple thermal diffusion apparatus has been constructed, and five gas mixtures containing hydrocarbons have been examined under various conditions. From the results of these experiments it is shown that the degree of separation obtained is less than that predicted from theoretical considerations, and that the effect of reducing the pressure is to increase the separation factor compared with a decrease predicted from theoretical considerations. J. W. H.

388. Patents on Chemistry and Physics of Petroleum. M. de Groote. U.S.P. 2,305,067, 15.12.42. Appl. 25.6.41.—Process for resolving petroleum emulsions of the water-in-oil type which involves subjecting the emulsion to the action of a demulsifying agent consisting of a water-soluble ester.

M. de Groote. U.S.P. 2,306,329, 22.12.42. Appl. 27.6.40. To break a petroleum emulsion of the water-in-oil type it is subjected to the action of a demulsifying agent consisting of compounds of the kind selected from the class having the following type formulæ:

$$\begin{array}{l} ND_2.T.(T.ND)x.ND_2 \\ \quad —(T.N.D)x.T.N.D.T.N.D— \\ \quad\quad | _____ | \end{array}$$

x is a whole number less than 10, but including 0; T is an oxyhydrocarbon radical selected from the class consisting of the keto type, the ether type, and the alcohol type; D is selected from the class consisting of hydrogen, alkyl, alkylol, hydroxyalkyloxyalkyl, aminoalkyl, hydroxyalkylamino, RCO, RCO.OX, RCO.OX′, RCO.OX″, RCO.OX‴, R′CO, R′CO.OX, R′CO.OX′, R′CO.OX″ and R′CO.OX‴ in which RCO is an acyl radical derived from a higher-molecular-weight carboxy acid having not more than 6 carbon atoms: R′CO is an acyl radical derived from a lower-molecular-weight carboxy acid having not more than 6 carbon atoms. OX represents a divalent radical obtained by removal of a hydroxyl hydrogen atom from a hydroxyalkyloxyalkyl radical; OX′ represents a divalent radical derived by the removal of an amino-

hydrogen atom from an aminoalkyl radical; and OX‴ represents a radical derived by removal of a hydroxy hydrogen atom from a hydroxyalkylamino radical.

J. H. Hirsch. U.S.P. 2,306,606, 29.12.42. Appl. 21.3.39. In an apparatus for determining the rate of gas formation capable of directly reflecting the extent of cracking in a conversion apparatus there are incorporated means for withdrawing a sample of the products of conversion, means for cooling the withdrawn products to condense the normally liquid hydrocarbons, a separating chamber in communication with the cooling member and adapted to separate gases from liquid. Additionally there are devices for controlling the amount of cooled products introduced into the separating chamber, for regulating the cooling and maintaining a constant temperature in the separating chamber; for withdrawing liquid therefrom at constant rate. There is a gas outlet from the separating chamber and a device for measuring the amount of gas flowing in it.

R. M. Barrer. U.S.P. 2,306,610, 29.12.42. Appl. 31.1.42. In the separation of straight-chain hydrocarbons from mixtures containing these and at least one substance selected from the group consisting of branched-chain hydrocarbons and cyclic hydrocarbons, the mixture is contacted with crystalline zeolites having rigid three-dimensional atomic networks and having interstitial dimensions sufficiently large to sorb the straight-chain hydrocarbons, but sufficiently small to exclude other hydrocarbons.

C. M. Blair. U.S.P. 2,306,775, 29.12.42. Appl. 17.8.40. Petroleum emulsions of the water-in-oil type are broken by subjecting the emulsion to the action of a demulsifier consisting of a chemical compound selected from the class consisting of amines and substituted ammonium compounds in which a divalent radical, obtained by removal of a hydrogen atom directly linked to the carbon atom of an acyl radical, links a nitrogen atom to the acyl alcoholiform oxygen atom of a high molar hydroxylated carboxy-acid compound. The hydroxy-acid compound is derived from an acid the acyl radical of which contains not fewer than eight nor more than thirty-two carbon atoms. The remaining nitrogen valences are satisfied in any suitable manner by a member of the class consisting of hydrogen atoms, the same type of radical previously described, hydrocarbon radicals, hydroxy hydrocarbon radicals, acylated hydrocarbon radicals, ring structures in which the nitrogen atom is part of the ring, and anions.

M. de Groote and B. Keiser. U.S.P. 2,307,494, 5.1.43. Appl. 7.7.41. For breaking petroleum emulsions of the water-in-oil type, a demulsifier consisting of water-insoluble oxy-alkylated drastically oxidized castor oil is used.

M. de Groote and B. Keiser. U.S.P. 2,307,495, 5.1.43. Appl. 7.7.41. For breaking petroleum emulsions of the water-in-oil type a demulsifying agent consisting of a drastically oxidized water-insoluble oxy-alkylated triricinolein is used.

L. Liberthson. U.S.P. 2,307,744, 12.1.43. Appl. 17.5.41. Preparation of a composition capable of forming substantially stable, non-foaming aqueous emulsions of the oil-in-water type. The composition consists of a normally liquid petroleum hydrocarbon, an aqueous phase emulsifying agent of the water-soluble soap type, and 0·25–1·0% of chromium oleate calculated on the emulsifying base. H. B. M.

Analysis and Testing.

389. The Infra-Red Prism Spectrograph as a Precision Instrument. R. A. Oetjen, C. L. Kao, and H. M. Randall. *Rev. Sci. Instr.*, 1942, **13** (12), 515.—The magnitude of the various factors which affect the accuracy of the infra-red spectrograph of the recording type has been investigated and the technique of the calibration of this instrument by means of the fine structure of CO_2, NH_3, and H_2O is given. By the use of these compounds and a grating instrument of comparable resolution fifty absorption lines between 5 μ and 15 μ are obtained for making the empirical calibration.
J. W. H.

Motor Fuels.

390. Patents on Motor Fuels. Anglo-Iranian Oil Co. E.P. 550,480, 11.1.43. Appl. 2.4.41.—Catalytic isomerization of normal paraffin hydrocarbons having at least four carbon atoms in the molecule is effected by contacting the original hydrocarbons

or a mixture containing normal paraffin hydrocarbons in the presence of hydrogen with a catalyst consisting of an oxide and/or a sulphide of a metal of Group 6 of the Periodic Table. Operating conditions are such that the normal paraffins may be isomerized or, alternatively, they may be converted in part to *iso*paraffins of lower molecular weight than the *iso*paraffins resulting from isomerization.

J. C. Munday. U.S.P. 2,305,026, 15.12.42. Appl. 7.12.38. To produce gasoline from low-boiling olefins and *iso*paraffins, the initial mixture is subjected to the action of an alkylation catalyst to produce a hydrocarbon having a wide boiling range. This product is divided into a heavy fraction and a light fraction. The latter fraction includes only those hydrocarbons which boil within the gasoline range. The heavy fraction is separately subjected to a further reaction with at least one hydrocarbon of the group consisting of *iso*paraffins and aromatic hydrocarbons. From the reaction mixture a hydrocarbon fraction is recovered which contains alkylated hydrocarbons boiling within the gasoline range. At least part of these are combined with the previously obtained light fraction.

D. A. Legge. U.S.P. 2,305,220, 15.12.42. Appl. 19.9.39. Hydrocarbon material, initially unsatisfactory for use as a motor fuel, is transformed into a high anti-knock gasoline by contacting the original material in vapour state and at a high temperature with a catalytic material consisting of an aluminium silicate. Silica and alumina are present in the catalytic material in the ratio of 0·8/1 to 1·2/1 by weight and the material is characterized by its fine porosity. It has a bulk specific gravity above 1·50 and a Mohs hardness above 2·5.

J. A. Chenicek. U.S.P. 2,305, 673, 22.12.42. Appl. 29.2.40. To prevent depreciation of an olefin-containing hydrocarbon distillate, a gasoline gum inhibitor and a hydroxy alkylene diamene is added to it.

J. A. Chenicek. U.S.P. 2,305,674, 22.12.42. Appl. 29.2.40. To prevent depreciation of an olefin-containing hydrocarbon distillate, a gasoline gum inhibitor and a hydroxy-alkyl substituted-alkylene diamine is added to it.

J. A. Chenicek. U.S.P. 2,305,675, 22.12.42. Appl. 29.2.40. A gasoline gum inhibitor and an aryl substituted-alkylene diamine are added to an olefin-containing hydrocarbon distillate to prevent deterioration.

J. A. Chenicek. U.S.P. 2,305,676, 22.12.42. Appl. 29.2.40. A gasoline gum inhibitor and a substituted alkylene diamene, wherein the substituent group is an amino-alkyl group, are added to cracked gasoline to prevent deterioration.

W. K. Simpson and C. G. Dryer. U.S.P. 2,305,742, 22.12.42. Appl. 25.3.39. In the treatment of gasoline with solid adsorbing refining agents, the life of the adsorbent agent is prolonged by treating the gasoline in the first place with a relatively small amount of a dilute aqueous solution of a mineral acid. The quantity of the solution is insufficient to effect any substantial refining of the gasoline. Afterwards the gasoline is refined by contacting it with the solid adsorbent at a temperature between 200° and 600° F.

F. M. McMillan. U.S.P. 2,306,253, 22.12.42. Appl. 29.11.41. The following processes are incorporated in the production of branched-chain hydrocarbons in the absence of any substantial hydrocarbon decomposition. A substantially paraffinic hydrocarbon mixture containing C_4 and C_5 hydrocarbons is fractionated in a fractionating zone to separate fractions respectively rich in normal butane and normal pentane. The normal butane fraction is contacted at a temperature between 100° and 200° C. with an aluminium halide catalyst in a first isomerizing zone. The pentane fraction in admixture with the effluent from the first isomerizing zone is contacted at a temperature between 40° and 120° C. with an aluminium halide catalyst in a second isomerizing zone. *iso*Butane and *iso*pentane are separated from the effluence of the second isomerizing zone and, in admixture with a fraction predominating in butylene and butane, they are contacted under alkylating conditions with an alkylation catalyst. In this way *iso*butane and *iso*pentane are reacted with butylene. Butane, *iso*butane, and *iso*pentane are separated as a vapour fraction from the products of alkylation, and this vapour fraction is passed to the fractionating zone.

H. E. Drennan and J. L. Farrell. U.S.P. 2,308,063, 12.1.43. Appl. 12.10.39. To improve the anti-knock qualities of liquid hydrocarbons, they are first vaporized and

the vapours are superheated to a temperature between 600° and 1500° F. Superheated vapours are passed through a bed of catalytic material of the clay type for the improvement of octane number. The catalytic material has previously been spent in the treatment of hydrocarbons to improve colour and gum characteristics. The quantity of catalytic material is so regulated in each stage that it is spent at approximately the same time for the specific improvement which it imparts to the hydrocarbon gases. H. B. M.

Lubricants and Lubrication.

391.* Conservation of Lubricating Oil. Oil Advisory Committee. Transvaal Chamber of Mines. *J. Inst. Pet.*, December 1942, **28** (228), 285–296.—A practical summary of suggestions made towards conserving lubricants on storage and use is presented. The report deals with lubricants for air-compressor cylinders, steam-engine cylinders, locomotives, wick oilers, bottle oilers, rock-drills, air motors, air-operated pumps and drill sharpeners, greases for plain bearings, ball and roller bearings, cocopan axles and open gears.

Further, the report treats briefly the problems met in compressor crank-cases, steam-engine crank-cases, steam-turbines, electrically-driven turbo compressors, hoist hydraulic systems, gear-boxes, gyratory crushers, diesel locomotives, ring-oiled bearings, motor-transport transformer and switch oils, cutting oils and compounds, and rope dressings for wire ropes.

Reconditioning of oils is outlined. A. H. N.

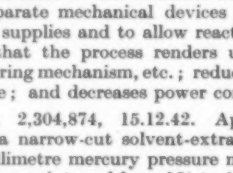
392. Patents on Lubricants and Lubrication. S. J. M. Auld, E. G. Ellis, and H. A. Walker. E.P. 550,429. 7.1.43. Appl. 25.7.41.—In the manufacture of lubricating grease from mineral oil and soaps, the component materials are passed at suitable temperatures to separate containers. The contents of the containers are delivered in fixed proportions by separate mechanical devices to a mixer large enough to accommodate the individual supplies and to allow reaction and homogenizing to be completed. It is claimed that the process renders unnecessary costly and complicated pans and kettles, stirring mechanism, etc.; reduces heating costs as the greases are made at low temperature; and decreases power consumption.

E. R. Barnard. U.S.P. 2,304,874, 15.12.42. Appl. 26.9.40. An improved lubricant is prepared from a narrow-cut solvent-extracted petroleum oil having a 90% distillation under 1 millimetre mercury pressure not substantially greater than 200° F. above the initial boiling point, and from 1% to 40% of an *iso*butylene polymer having a Saybolt viscosity at 210° F. of 185–500 sec. and a flash-point between 350° and 450° F.

R. Rosen and B. W. Geddes. U.S.P. 2,305,034, 15.12.42. Appl. 20.12.39. An improved mineral-oil composition is prepared by admixing with a petroleum-oil fraction not more than 5% of an organic base having a heterocyclic structure containing nitrogen, and not more than 0·1% of sulphur. The sulphur is present in an organic compound which is an antioxidant for petroleum oils.

B. H. Lincoln and G. D. Byrkit. U.S.P. 2,305,627, 22.12.42. Appl. 24.5.39. A lubricant is prepared by adding a small proportion of a tin- and halogen-bearing reaction product of a stannic halide and a beta-diketone to an oil of lubricating viscosity.

E. W. Cook and W. D. Thomas, Jr. U.S.P. 2,306,354, 22.12.42. Appl. 29.11.41. Preparation of a lubricant containing a compound of the general formula:



X_1 and X_2 are alkylene radicals containing two to four carbon atoms inclusive, n is a positive integer not more than two, and R_1 and R_2 are members of the group consisting of alkyl, *cyclo*alkyl, and hydrogen radicals. At least one R_1 and at least one R_2 are members of the group consisting of alkyl and *cyclo*alkyl radicals.

E. B. McConnell and J. M. Musselman. U.S.P. 2,306,971, 29.12.42. Appl. 16.8.39. A small amount of the reaction product obtained by heating molar proportions of triamylamine and sulphur is added to lubricating oils to improve their quality.

J. C. Zimmer and A. J. Morway. U.S.P. 2,307,183, 5.1.43. Appl. 9.5.39. An extreme-pressure lubricant consists of a mineral lubricating oil, an oil sulphurized fatty oil, and a soluble reaction product of phosphorus sesquisulphide with a halogenated aliphatic hydrocarbon compound containing at least 5% halogen.

B. H. Shoemaker. U.S.P. 2,307,307, 5.1.43. Appl. 12.9.38. Preparation of an extreme-pressure lubricant containing a lubricating oil and a thioketo polysulphide having the general formula $(RXC = S)2S_n$. R is a radical selected from the group consisting of alkyl, chloralkyl, aryl, and chloraryl radicals; X is an element selected from the group consisting of oxygen and sulphur; and n is an integer greater than two. The thioketo polysulphide is used in small but sufficient quantities to impart extreme pressure qualities to the lubricant.

E. J. Barth. U.S.P. 2,307,615, 5.1.43. Appl. 8.3.41. A liquid lubricating-oil composition is prepared by admixing with a petroleum lubricating oil a small amount of an oil-soluble calcium phenolate selected from the group consisting of calcium orthokeptophenolates and substituted derivatives thereof having at least one alkyl group directly attached to the basic phenol ring.

A. H. Gleason. U.S.P. 2,307,885, 12.1.43. Appl. 16.7.40. Preparation of a lubricating product consisting of a hydrocarbon lubricating oil blended with 0·2–5% of a vinyl phenol polymer in which the hydroxyl groups are esterified to render the polymer soluble in the hydrocarbon oil.

I. Silverman. U.S.P. 2,308,116, 12.1.43. Appl. 11.7.40. Preparation of a lubricant of relatively low, substantially non-fugitive, non-reverting pour point consisting of a wax-containing petroleum hydrocarbon oil, having normally a relatively high pour point due to the wax, a metallic soap pour point depressant, and an oil-soluble metallic petroleum sulphonate.

T. G. Rochner and L. H. Sudholz. U.S.P. 2,308,427, 12.1.43. Appl. 16.10.40. Sulphurized Vinifera palm oil is added to a mineral-oil lubricant to confer exhanced extreme-pressure lubrication qualities. If desired the Vinifera palm oil can previously be reacted with phosphorus. H. B. M.

Asphalt and Bitumen.

393. Patents on Asphalt and Bitumen. B. A. Anderton. U.S.P. 2,304,773, 15.12.42. Appl. 16.7.38. A heat-stable bituminous product, especially suitable for application by remelting, is obtained in the following manner. A digesting medium consisting of tar-oil and pitch constituents is heated with between 7% and 25% of a coal of the group consisting of bituminous and sub-bituminous coal to a temperature between 20° and 100° above the digestion temperature corresponding to a product of maximum softening point. The final bituminous product has a softening point between 50° and 90° C., a penetration at 0° C. of at least four and a penetration at 25° C. of not more than five times the penetration at 0° C.

H. M. Noel. U.S.P. 2,305,440, 15.12.42. Appl. 25.7.40. A hard, unoxidized bituminous material suitable for use in a storage-battery compound is prepared from cracked and vacuum distilled paraffin-free asphaltic-base petroleum crude oil having a susceptibility factor between 27 and 35, and a softening point between 320° and 420° F. Material insoluble in carbon disulphide is less than 1·5%. Manufacture entails cracking a paraffin-free asphaltic-base West Venezuela crude to a residual bottoms

oil having a gravity viscosity relationship of 8–9° A.P.I. gravity and Furol viscosity of between 1000 and 1400 sec. to between 600 and 850 sec. at 122° F. respectively. The residual oil is distilled under vacuum to obtain a residue of bituminous material of desired viscosity and susceptibility factor.

R. L. Ortynsky. U.S.P. 2,308,245, 12.1.43. Appl. 28.6.41. To produce a Mexican-type paving composition an asphalt of the following composition is oxidized: Asphaltenes 1·5–5%; petroleum resins, 55–65%; and aromatic oil the balance. The resins and the oil have specific dispersions above 200 and flash-points above 500° F. The oxidized asphalt has an asphaltene content of 50–60% and a softening point of at least 360° F. This is fluxed with 1·1–1·6 parts of petroleum extract per part of oxidized asphalt. The extract has a Saybolt furol viscosity of 30–200 at 275° F. and a flash-point of at least 500° F. With the resulting fluxed asphalt is blended an amount of a hydrocarbon distillate sufficient to produce a blended asphalt having a penetration of 25–200 at 77° F. H. B. M.

Special Products.

394.* Chemicals from Petroleum—Formaldehyde. W. T. Ziegenhain. *Oil Gas J.*, 15.10.42, **41** (23), 34.—Substantial quantities of formaldehyde are being made by controlled oxidation of natural gas, the largest plant being located in the Mid-Continent.

The principal commercial products obtained are formaldehyde, methanol, and acetaldehyde. Methods of manufacture and separation of the three products from one another are briefly described and properties and applications of formaldehyde are outlined. Production from natural gas has been on a continuous and expanding basis since 1928. R. A. E.

395. Progress in Plant Insecticides. S. H. Harper. *Chem. Prod.*, November/December 1942, **6** (1/2) 5.—A review, with bibliography, is given of recent developments in the use, structure, and determination of vegetable insecticides—*e.g.*, nicotine, pyrethrum, derris and cubé roots, and quassia. The problem of poisoning of honey-bees by lead arsenate sprays is being attacked by the testing of various essential oils as repellents, and of nicotine-bentonite oil-sprays, which are claimed to be as toxic to pests but less phytocidal. The export of concentrated extracts of pyrethrum, instead of the flowers, and cultivation in this country is suggested. Pyrethrum extracts in kerosine are recommended for control of bugs, etc., in air-raid shelters, and mists of pyrethrum in mineral oil for control of pests in stored food produce. In oil solution there is little difference between the toxicities of pyrethrum I and pyrethrum II, although the latter is chiefly responsible for knockdown. More attention is being paid to the chemical and biological standardization of pyrethrum. The risk of dermatitis when pyrethrum preparations are used for scabies and louse control is believed to be due to the presence of a steam volatile essential oil. Pyrethrum is also effective as a repellent for midges and mosquitoes. Reduction of the toxic concentration of pyrethrum is being attempted by the use of synergists such as sesame oil.

The structure and toxicity of the constituents of derris and cubé roots are being investigated, it being shown that rotenone is not the only active constituent. Previous constituents extracted by alkali and found to be ineffective are now believed to have been present in the optically active form, but have suffered racemization by alkali and become non-toxic. A method of evaluating the toxicity from the sum of the rotenone concentrate, $\frac{1}{3}$th of deguelin concentrate and $\frac{1}{15}$th of the toxicarol concentrate has now been worked out. Derris solutions in petroleum oil sprays, containing a mutual solvent, are giving better control of citrus-red scale in California. Control of head louse, body louse, and scabies by rotenone or derris-root creams, lotions, etc., is reported. Quassia is reported as giving good control of sawfly.

C. L. G.

396. Acid Sludge in the Manufacture of Superphosphate. Anon. *Chem. Trade J.*, 19.2.43, **112**, 166.—Acid sludge from the Haifa refinery, containing about 50% H_2SO_4, is being supplied to manufacturers of superphosphate for fertilizer production. A

good quality superphosphate can be made with this acid tar from Transjordan phosphate (69–75% tricalcuum phosphate). C. L. G.

397. Patents on Special Products. Anglo-Iranian Oil Co. E.P. 550,389, 6.1.43. Appl. 5.3.41.—The patent relates to a catalytic process for the preparation of 2 : 4-dimethylpentane from 2 : 3-dimethylpentane or of 2 : 3-dimethylpentane from 2 : 4-dimethylpentane. The hydrocarbon which is to be converted is contacted with concentrated sulphuric acid as catalyst under conditions of vigorous stirring of the reaction mixture at a temperature in the range − 10° C. to 50° C. In addition to the advantages to be derived from increased octane number by converting 2 : 4-dimethylpentane to the 2 : 3 form, the reverse conversion is advantageous, for instance, when the 2 : 3 isomer is associated with low-octane-number paraffins of nearly related boiling point, such as methylhexanes, from which it cannot be separated by fractionation.

J. G. Fife. E.P. 550,776, 25.1.43. Appl. 3.6.41. In a process for the treatment of saturated non-cyclic hydrocarbons in the vapour phase with an aluminium halide in the presence of a hydrogen halide, the concentration of the hydrogen halide in the treating zone is maintained below that causing degradation of the hydrocarbons under the conditions of treatment. As the catalyst declines in activity the concentration of the hydrogen halide in the treating zone is increased. The process has particular application to the vapour-phase isomerization of butane with the aid of aluminium chloride.

F. O. Rice and W. D. Walters. U.S.P. 2,305,635, 22.12.42. Appl. 25.10.40. Higher-molecular-weight hydrocarbons are converted to lower-molecular-weight hydrocarbons by heating to a conversion temperature in the presence of a relatively small amount of diacetyl.

S. H. White. U.S.P. 2,305,752, 22.12.43. Appl. 2.10.40. A gaseous fuel suitable for use with oxygen in a blow-pipe contains a gas of low calorific value from the group consisting of coal gas, natural gas, and illuminating gas, mixed with propane and ether. Proportions are approximately 1 part of propane to 0·375 part of ether. The quantity of propane and ether is sufficient to increase the calorific value of the gas, and in any event is not materially less than 20%.

S. H. White. U.S.P. 2,305,753, 22.12.42. Appl. 2.10.40. A gaseous fuel suitable for use with oxygen in a blow-pipe contains a member of the group consisting of propane and butane mixed in a liquid stated with not less than 16% nor more than 21% by weight of ether. The fuel is used in the same way as acetylene or hydrogen in application to metals.

E. M. Marks. U.S.P. 2,306,218, 22.12.42. Appl. 27.9.41. Hydrocarbon stock is converted into other hydrocarbons by contacting it with a catalyst consisting of aluminium oxide and an alkali metal borate at suitable temperature. The catalyst contains 5–15% by weight of water.

L. Liberthson and M. Blumer. U.S.P. 2,307,743, 12.1.43. Appl. 7.1.41. To obtain an improved petroleum sulphonate product a solution of a petroleum sulphonate stock, derived from the acid treatment of a petroleum lubricating-oil distillate under sulphonating conditions, is contacted in the presence of water, in a solvent for the sulphonate with an alkali metal chlorite. Conditions are adjusted in regard to quantities and length of contact to produce a product having a Lovibond colour of less than 8R at a *p*H substantially below 7. Afterwards a petroleum sulphonate product substantially stable during storage and substantially non-darkening at elevated temperatures is recovered. H. B. M.

Detonation and Engines.

398. Patent on Detonation and Engines. G. B. Banks. U.S.P. 2,306,372, 29.12.42. Appl. 26.3.40.—A gasoline knock-recorder comprises a tubular member connected at one end to a source of variable fluid-pressure supply, primary and secondary transformer coils about a portion of that member, a core which slides in the member and which

is normally held substantially within the magnetic field of the primary coil. Movement of the core in the direction of the secondary coil transfers electric energy from the primary to the secondary coil. A reduced-diameter bypass duct is connected to the tubular member to bypass a quantity of fluid pressure to the end of the core adjacent to the secondary coil. The movement of the core is thus cushioned in one direction. H. B. M.

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Geology and Development.

399.* Production Outlook for 1943. D. R. Knowlton. *World Petrol.*, January 1943, **14** (1), 34.—The proved oil reserves of U.S.A. are about 20,000,000,000 brl., which would take 30–50 years to produce, and the present, or an increased, rate of production cannot be maintained for long unless additional reserves are discovered at a rate at least equal to the rate of production. It seems likely that U.S.A. will have to supply more than its proportionate share of oil production during the war, and it is agreed that the demand for all types of products in 1943 will exceed the demand of 1942.

A general and substantial increase in the rate of production from most of the present fields must be considered as an emergency measure which should be adopted only as a last resort. A limited number of fields in the south-west have an important excess of unused efficient producing capacity, but this is not readily accessible because of transport difficulties arising from the war. Production in excess of the maximum efficient rate accelerates the decline in productive capacity, and reduces the recoverable reserves in many cases. Hence the maintenance of reserves at a level sufficient to meet demands is encouraged.

In the last four years wildcatting results have been disappointing, with a diminishing discovery of reserves per wildcat. In the three-year period, 1936–1938 inclusive, an average of 2263 wildcats were drilled each year, and an average of 806,000 brl. of new reserves were discovered per wildcat. The corresponding figures for the three-year period 1939–1941, inclusive, were 2963 wildcats per year, and only 216,000 brl. of new reserves per wildcat. Since 1934 the number of fields discovered per year has increased, but the average size of the new fields has fallen from nearly 20,000,000 brl. per field in 1934 to 1,200,000 brl. per field in 1941.

About 3100 wildcats were drilled in 1942, and based on the poor results of previous years 50% more will be required in 1943. 11,500 development wells are planned for 1943. The order of priority in the allotment of materials will be first wildcatting and related exploratory wells, repair and maintenance of producing wells, and lastly development wells.

In order that the smaller number of development wells in 1943 will give adequate production, locations must be carefully selected, and the most efficient production technique applied. Old wells must be reworked, and repressuring, pressure maintenance, and water-flushing applied. G. D. H.

400.* Well Completions of 1942 34% under 1941. Anon. *Oil Wkly*, 11.1.43, **108** (6), 33.—21,217 wells were completed in U.S.A. in 1942, 34% fewer than in 1941. In the Middle West and Upper Mid-Continent, drilling in 1942 was curtailed by 25–50%, in Kansas 28%, in Oklahoma 34%, in Indiana 32%, in Illinois 46%, in Ohio 36%, in Kentucky 50%, in Michigan 25%, in New Mexico 3·5%, in Arkansas 32%, in North Louisiana 40%, in South Louisiana 44%, in Mississippi 50%, in Texas 50%, in California 27%, in Colorado 28%, in Montana 23%, and in Wyoming 29%.

Tables give, by States and districts, details of drilling activity on 1st January, 1943, and the numbers of rigs operating on 1st January and 1st December, 1942; also the types of completions in December 1942, cumulative data for 1942, and the changes which have taken place as compared with 1941. G. D. H.

401. The Petroleum Shortage in the United States. B. T. Brooks and L. C. Snider. *Oil Gas J.*, 21.1.43, **41** (37), 26.—If the rate of finding new oil shown in the U.S.A. in the last three years continues during the next three years, and production is forced to meet current needs, the damage to many fields will rapidly accentuate the oil shortage, while estimates of net ultimate producible oil from known reserves will have to be revised sharply downwards. R. K. Davies, W. V. Howard, W. P. Cole, E. L. DeGolyer, and H. B. Soyster have all pointed to declining discovery rates and other signs of a possible shortage. However, it is almost certain that sufficient oil can be produced to meet requirements in the next two years, but with the declining discovery rate and decline in production from existing fields it is equally certain that the critical rate of production of many fields will be exceeded, with consequent damage and reduction of ultimate recovery. In this sense a shortage has already developed.

Proven reserves are generally agreed to be 19,000,000,000 to 20,000,000,000 brl., or 5,000,000,000 brl. more than in 1936. The existence of a critical rate of production

has been recognized, and to obtain a high recovery by means of the optimum rate of production calls for a much larger reserve than when the old flush methods of production were practised.

For many years about 50% of the U.S. production has been from new flush wells constituting about 2% of the total producing wells. Since the greater efficiency of restricted production has been demonstrated the estimates of recoverable oil have been revised upwards, both for old and for new fields. But this revision would be nullified if efficient rates of production are exceeded.

After allowing for shrinkage and connate water, it is now estimated that the ultimate recovery of oil in some fields has been as high as 80% or even 90%.

It is not certain that substantially increased production would be obtained by raising the price of oil to induce greater discovery effort.

Venezuela's oil output might be restored to its former level if adequate transport with naval protection were available. There is little likelihood of a substantial rise in Mexico's oil production in the immediate future.

It does not yet seem necessary to turn to oil from coal and shale to avert a shortage, and such a step would not be profitable while oil prices are at anything like their present levels.

The question of an adequate supply of crude oil during the war is further complicated by the need to manufacture enormous quantities of high-octane aviation fuel, to meet an increased demand for fuel oils, and to provide raw materials for the manufacture of synthetic rubber, toluene, and other special products. G. D. H.

402.* **Alberta Reached Top Production in 1942.** Anon. *Oil Wkly*, 25.1.43, **108** (8), 42.—The Alberta oil production is estimated to have been 10,150,000 brl. in 1942, compared with 9,908,000 brl. in 1941. The 1942 peak rate of production was in February and March with 30,000–31,000 brl./day. At the end of the year the production was at the rate of 27,600 brl./day, due to a slump in drilling in proven and prospective oil areas.

Much of the Alberta production has gone to aid the construction of the Alaskan highway, while 87-octane fuel has been provided for the Commonwealth Air Training plan. Preparations have been made for the production of 100-octane fuel.

G. D. H.

403. **Proven Reserves.** W. V. Howard. *Oil Gas J.*, 28.1.43, **41** (38), 64–66.—On 1st January, 1943, the U.S. proven oil reserves were estimated to be 20,675,899,000 brl., 543,140,000 brl. less than the revised estimates for 1st January, 1942. New fields added 322,808,000 brl. to the reserves in 1942, and extensions added 518,580,000 brl. The corresponding figures for 1941 were 486,935,000 brl. from new fields and 1,009,175,000 brl. from extensions. During 1942 the reserves of Colorado, New Mexico and North Louisiana increased. In California the reserve figure fell during 1942 from 14·5 to 12·8 years' supply, due to lack of discoveries and to increased rate of production. Transport difficulties caused production to be reduced in parts of Texas, and therefore in most of Texas the reserves rose in terms of years' supply. The new additions to reserves in Oklahoma were 60% below the output, and in Kansas the discoveries were 50% of the output. There was decided over-production in Illinois, Indiana, Michigan, Mississippi, and Nebraska.

The revision of the reserve estimates of 1st January, 1942, have been upward throughout the U.S.A., but this revision does not increase the estimates of immediately recoverable oil, since most of the fields involved are either producing to capacity or producing at a rate consistent with good engineering practice.

While the discoveries in 1942 were as numerous as in 1941, the average reserve of each was only two-thirds of the 1941 figure. No major fields were found in the northern extension of the production in the San Joaquin Valley. California's ability to produce has been increased by re-drilling several old heavy-oil fields. In Wyoming deep pays discovered in old fields were the greatest in interest, except for an oil find on the northern side of the Denver basin. New trends parallel to the main Artesia–Vacuum fields have been found in New Mexico, Square Lake being the most important discovery. The Ellenburger is proving of increasing importance, and production is extending to the north-west in the Permian pays. Many small fields have been found in North Central Texas.

Many areas have been tested to the lowest possible producing horizon. In the

Eastern States no important production has been found below the top of the Trenton, and this formation has given little oil east of the Cincinnati Arch. Illinois and Michigan have production possibilities within a few thousand feet of present levels. No Cambrian production has yet been found in Oklahoma, but Kansas has some Cambrian production. The Ellenburger possibilities are of prime importance in North Texas and in West Texas. Lower Cretaceous and Jurassic horizons have not been tested in East Texas and in the adjacent parts of Arkansas and Louisiana. Much Tensleep and Embar production has been found in the Rocky Mountain area, where the Palæozoic offers lower possibilities.

A table gives by States and districts the estimated reserves as of 1st January, 1942, and 1st January, 1943; the reserves due to 1942 discoveries and extensions, and the total years' supply as of 1st January 1942, and 1st January, 1943. G. D. H.

404. Discoveries and Extensions by Districts. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 66–71.—The discoveries and extensions are listed by States and districts, with their names and locations, producing horizon, proven acreage, formation thickness, and estimated reserves. Maps show the positions of the new discoveries and extensions. G. D. H.

405. Wartime Regulations Sharply Reduce Drilling Operations During 1942. W. V. Howard. *Oil Gas J.*, 28.1.43, **41** (38), 72.—In 1942 18,150 wells were completed, 40% fewer than in 1941. The fall was due to unsatisfactory prices, M-68, and a lack of locations.

Except for the new Burbank field in Kentucky, wells in that State, and in most of Ohio, West Virginia, and in all of New York and Pennsylvania, are small producers, so that wells drilled under present price conditions are generally unprofitable. The initial outputs in Illinois, Michigan, and Indiana are generally higher, but the lack of locations affects the position. Multiple completions in these three States make profitable wells when all the producing horizons are within depths wherein the 10-20-acre spacing ruling operates.

In Kansas, Peace Creek and Lindsborg were active throughout 1942, and many extensions are reported from the older fields, chief among which was the merging of several smaller pools into the Kraft-Prusa field. It is possible that Hall-Gurney, Gorham, and Big Creek may eventually merge. Drilling dropped by nearly 50% in Oklahoma in 1942, and it also fell sharply in the Gulf Coastal district. The decline in drilling was less in the Rocky Mountain States and in California than elsewhere. The average footage of the wells drilled in California last year was 1704 ft. less than in 1941.

There seem to be few areas in U.S.A. where there is much possibility of increased drilling in 1943, and unless there is price relief, increased transport, and some relaxation of drilling restrictions, it is unlikely that many more than 16,000 wells will be drilled in 1943.

A table gives by States and districts the total completions in 1942; the numbers of oil, gas and dry wells, and the footage; the total number of wells in 1941. Curves show the total completions, numbers of dry holes, and the average prices year by year since 1910. G. D. H.

406. Production Stays at Peak Level. W. V. Howard. *Oil Gas J.*, 28.1.43, **41** (38), 78.—During 1942 U.S.A. produced 1,384,542,000 brl. of oil, 7,378,000 brl. less than in 1941. 85·8% of the 1942 total came from Texas, California, Oklahoma, Louisiana, Illinois, and Kansas. Louisiana and Kansas had their peak outputs in 1942, and California approached its 1938 peak. During 1942 the Illinois and Oklahoma outputs declined by 22,268,000 brl. and 16,406,000 brl. respectively, in spite of heavy demands. The Kansas output rose by 14,980,000 brl. in 1942, while the New Mexico production fell by 6,567,000 brl., a fall which can easily be removed when transport is available. Indiana gave more oil in 1942 than in any year since 1905. The development of several good fields caused a substantial rise in production in Michigan in 1942. The Montana output was at a peak, and Wyoming's production at its highest level since 1924, while Colorado gave more oil than in any year since the late twenties.

The production is tabulated by States yearly since 1935, and curves show the annual production of the leading States since 1930. G. D. H.

407. World Production Slumps but Revival this Year is Indicated. J. P. O'Donnell. *Oil Gas J.*, 28.1.43, **41** (38), 94.—It is estimated that in 1942 the world oil production totalled 2,062,500,000 brl., compared with 2,227,125,000 brl. in 1941. The effect of lack of transport was 75% greater than that of destruction of fields in reducing the total output. Thus lack of transport reduced the production of Venezuela and Colombia by 86,500,000 brl. in 1942. The North American production fell by 24,360,000 brl., the bulk of the decline being in U.S.A., although Mexico experienced a further decline, largely due to transport difficulties. The Canadian output rose by 3%.

Venezuela's production fell 32% (72,350,000 brl.) and Colombia's production fell 57% (14,050,000 brl.) in 1942. Until tanker movements are easier neither country is likely to return to a state of higher production. Both countries had new discoveries in 1942. Trinidad's output of oil rose in 1942, and Argentina had a 7% rise.

During 1942 the Maikop fields were captured by Germany and the pipe-line outlet from Grozny was interrupted. The Germans also gained partial control of the Volga. A doubling of the Ural–Volga production to 100,000 brl./day offset these Russian losses to some extent. The Hungarian oil output is said to be 12,000 brl./day, and possibly 15,000–17,000 brl./day.

The Netherlands and British East Indian and Burmah fields were captured by Japan in 1942, and this increased Near East development. Japan has probably derived little oil so far from her conquests.

The 1943 world oil production is unlikely to reach the 1941 level. G. D. H.

408. Permian Basin, Panhandle: Ellenburger and Clear Fork Provide Important Discoveries in Basin. H. F. Simons. *Oil Gas J.*, 28.1.43, **41** (38), 113.—During 1942 two new Ellenburger pools, Monahans in Ward County and Embar-Ellenburger in Andrews County, gave some indication of the deeper possibilities in the Permian Basin. Fullerton in Andrews County was the major Clear Fork discovery, the discovery well being completed at a depth of 7280 ft. for 707 brl./day of 44-gravity oil. This pool now has ten wells averaging 600 brl./day initially, with a pay-zone 150–500 ft. thick; it may become a major pool and establish a new trend between two lines of major development. The Embar–Permian pool, another Clear Fork find, came in at 6210 ft. for 264 brl./day. Ellenburger production has been developed in the same pool. The Clear Fork Monahans discovery was made in a well which was intended to test the Ellenburger. The Monahans (Ellenburger) pool has 280 ft. of pay, topped at 10,082 ft. in the discovery well which came in at 2852 brl./day. Geophysical work has shown the Monahans structure to be large.

Nine more Ellenburger producers have been completed at Barnhart. At the end of 1942 the Slaughter pool covered 72,000 acres, and it has not yet been defined on the north side. The San Andres lime pay averages 100 ft. in thickness.

Fifty-nine exploratory wells were drilled in the Permian Basin in 1942 to an average depth of 3500 ft. Lack of outlets curtailed production in this area.

Tables give the cumulative production and estimated reserves on 1st January, 1943, and the number of wells in each field of West Texas and the Panhandle, together with the completions in 1942, and the number of completions and footage each month. G. D. H.

409. Square Lake Develops into Major Pool. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 117.—Ninety-nine oil wells and a small gasser have been completed at Square Lake in South-east New Mexico. The discovery well was completed at 2903–2978 ft. for 200 brl./day. Maljamar has thirty-five new producing wells in the Whitehorse and the Queen lime. During 1942 interest was revived in the Jackson–Grayburg area, which has a pay zone in the Whitehorse lime at about 3300 ft.

Oil is found at about 500 ft. in the Shallow Red Lake district, where twelve wells were completed with average initial outputs of 50 brl./day. At East Lusk seven oil wells have been completed at a depth of 2700 ft. with an average potential of 200 brl./day from the Whitehorse lime. The Arrowhead pool has been extended to the north.

Shows have been found at about 5000 ft. in the Permian at Langlie in Lea County, and another Lea County well has swabbed a little oil.

The 1942 well completions in South-east New Mexico are tabulated, along with the cumulative production and estimated reserves on 1st January, 1943. G. D. H.

410. Four Small Fields Found in California in 1942. L. P. Stockman. *Oil, Gas J.*, 28.1.43, **41** (38), 118.—California's crude oil reserves were substantially reduced in 1942, in which year two gas-fields and the Antelope Plains, East Strand, Buena Park and Holser oil-fields were discovered. These fields are not of major importance. The reduction in reserves was aggravated by the lack of permission to drill to the Tar zone at Wilmington. A similar situation obtains at Inglewood, where drilling in the Sentous (Miocene) zone has been suspended. The Wilmington Tar zone may have a reserve of 50,000,000 brl., but this is not yet proved.

Production in 1942 in California was at the highest rate for a number of years, and it may be at a still higher rate in 1943. 556 oil wells and 25 gas wells were completed in 1942 out of a total of 828 wells. If the percentage of failures in 1943 is as high, 1000 wells will have to be drilled. None of the wildcats shows great promise, and interest in the Cretaceous has declined since gas only has so far been found. Several fields have proved deep zones which will have to be produced if new prolific fields are not discovered in 1943.

California is not producing to capacity, because of bottlenecks.

It is intended to use the Playa Del Rey field for storage of the surplus gas produced in the summer.

The cumulative production and the estimated reserves on 1st January, 1943, are tabulated by fields, and there is a summary of the types of completions in the various fields, and the numbers of completions and the footage drilled each month.

G. D. H.

411. Oklahoma : Pauls Valley and East Watchorn Pools are Leading Discoveries in 1942. C. Hoot. *Oil Gas J.*, 28.1.43, **41** (38), 125.—The 1942 oil production in Oklahoma was bolstered to some extent by edge wells and reworking programmes. Oil wells constituted only 46% of the completions. Fifty new oil- and gas-fields, extensions, and new zones were opened in 1942, with Pauls Valley probably the best find. Pauls Valley produces from the Wilcox and Pennsylvanian, and the field has been defined at its northern and southern ends.

The Apache pool has been extended to the north-west. Late in 1942 the Ardmore Springer sand pool was opened at a depth of 3079–3302 ft. Further wells have been completed in this pool. The Cumberland pool has been extended to the west, and a new pay was discovered at a depth of 5472 ft.

Tables give the cumulative production and the estimated reserves by fields on 1st January, 1943, together with the total well completions and types. G. D. H.

412. Western Side of Illinois Basin Produces Outstanding Fields of Year. H. David. *Oil Gas J.*, 28.1.43, **41** (38), 131.—The high discovery rate was maintained in the southern half of Illinois in 1942, but no large flush pools were found. Hence the oil reserves declined for the first time since 1937. 106,282,000 brl. of oil were produced in 1942, and 1809 wells were completed, compared with 3838 wells in 1941. During 1942 there was an increase in activity in the Louden and Centralia–Salem areas and on the western rim of the basin, where the Devonian and Trenton limes were the main objectives. Devonian production was found at Boulder and Bartelso South, and Trenton production at St. Jacob. Late in December 1942 a 700-brl. well was completed in the Devonian 50 ml. north-west of the nearest Devonian production at Louden.

The Boulder field has been producing from the Benoist, but late in 1942 a second Devonian well was completed. St. Jacob is the most prolific Trenton field in Illinois, and has encouraged the drilling of further Trenton tests on the western rim of the basin.

The Covington pool covers 1200 acres, and produces from the Aux Vases, Levias, and McClosky. It has already given 1,159,000 brl. of oil. The Blairsville and Markham City pool wells have high initial outputs from the Aux Vases and McClosky. Oil is obtained from the Cypress, Aux Vases, and McClosky in the Iola field.

A new pay, the Glen Dean limestone, has been found in the middle of the Chester series, and is giving oil at South Sailor Springs. Early in 1943 Devonian production was discovered in the Patoka field.

The cumulative production and estimated reserves on 1st January, 1943, are tabulated by fields, and there is a summary of the types of completions and the number of completions each month in 1942. G. D. H.

413. North Central Texas: Bend and Mississippian Pays Yield Many Discoveries. H. F. Simons. *Oil Gas J.*, 28.1.43, **41** (38), 137.—Forty-one of the 105 wildcats completed in North Central Texas in 1942 opened new pools or extended old ones. Bend discoveries were made in the Wasson, Forestburg, Sanders, Joy, Hoefle, Spring, Worsham-Steed, East Bryson, Eanes, McKnight, Park Springs, Kisinger, Garvey, Daws, and Hobart pools, while Mississippian pays were opened at Joy, Alma, Mathews, Padgitt, Ragland, and Knox, with the wells averaging about 1000 brl./day initially. Several Ordovician tests were drilled at various points in the basin, production being found in the Ellenburger and Simpson. During 1942 fifty-nine wells proving 2400 acres in the Ellenburger have been drilled at K.M.A. The presence of the Viola has been proved in North Central Texas, but the formation has not yet been shown to be as productive as in Kansas and Oklahoma.

Strawn production has been obtained in many fields which yield oil from the Caddo and the Marble Falls. The chief Strawn developments were at Joy, Illinois Bend, Mount View, Ketchum, Talbot, and Watson.

During 1942 the principal additions to reserves were made at Watson, Forestburg, Padgitt, Joy, K.M.A., Strawn, Ellenburger, New York City, Ringgold, and Ross, but the numerous small additions made in other fields make up an important total.

Tables give by fields the cumulative production and estimated reserves by fields on 1st January, 1943, and the numbers of completions of various types.

G. D. H.

414. Wimberly Expansion Leads in West Central District. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 139.—The extent of the Wimberly field has now been fairly well determined, twenty-nine new oil wells having been completed. Oil is obtained from the lower Tannehill sand, Flippin lime, lower Hope lime, possibly from the Bluff Creek lime, from the Brookover lime and the Gunsight lime. Acid treatment of a Hope lime well raised its production from 20 brl./day to 500 brl./day.

The Coker field, a 1942 discovery, produces from the Strawn series at a depth of about 3000 ft. The structure is believed to be small, and the pool's limits have been defined in the south and west. The Reddin pool was opened with production from the lower Hope lime of the Cisco series at a depth of 2250 ft.

Nine other less important fields were found during 1942.

The cumulative production and estimated reserves on 1st January, 1943, are tabulated by fields, together with a summary of the completions. G. D. H.

415. Texas Gulf Coast: Mercy Field Developments Most Important on Gulf Coast. T. F. Smiley, *Oil Gas J.*, 28.1.43, **41** (38), 142.—The Mercy Wilcox sand field came in in 1942 at 8273–8279 ft. for 583 brl./day. Mercy is believed to embrace a greater area of Wilcox sand than any other field on the Gulf Coast except Joe's Lake.

The North Bay City field was opened at 7870–7873 ft. with a flow of 309 brl./day. Three miles south-east of Orange Hill a well was completed at 9052–9067 ft. for 105 brl. of oil and 8,750,000 cu. ft. of gas/day. The Mayo field discovery well was brought in at 5408–5414 ft. for 115 brl./day, and this field now has 23 wells, 21 being oil wells and one a gas well.

The Harmon field of Jackson County was opened in May at a depth of 5356–5374 ft., and nine producers have been completed.

Tabulated summaries are given of the wildcats completed in 1942, and of the other completions, while the production in 1942, the cumulative production and the estimated reserves on 1st January, 1943, are also listed. G. D. H.

416. Kansas Wildcat Completions Increase 64 per cent. over 1941. C. Hoot. *Oil Gas J.*, 28.1.43, **41** (38), 147.—During 1942, 351 wildcats were completed compared with 214 in 1941, and of these thirty-four were oil wells and three gas wells. The 1519 field completions of 1942 were 28% below the 1941 figure. During 1942 production rose from 265,000 brl./day to over 310,000 brl./day, an all-time high.

The Peace Creek Viola lime pool was the outstanding Kansas development of 1942. It was discovered in 1941 and developed rapidly in 1942 to give over 280,000 brl./month from 100 wells. This stratigraphic trap pool is now nearly nine miles long, and has been defined only on the south and south-east margins.

There were important developments on the Barton Arch during 1942, a number of wildcats having located oil, generally near existing pools. The Kraft–Prusa area has

spread to include a number of adjoining fields and is approaching the Breford–Bloomer area. Trapp has taken in Susank and North Ainsworth. The trend running from Burnett and Bemis–Shutts to Bloomer–Wilkins and Stoltenberg may eventually merge into a continuous producing area.

The Lindsborg pool has expanded rapidly, and now produces from the Simpson and Viola. A show of oil has been reported in the Mississippian chat at a depth of 2379–2383 ft. in south-east Saline County, where there have been many dry holes.

The 1942 production and the cumulative production and estimated reserves on 1st January, 1943, are tabulated by fields, and there are summaries of the types of well completions. G. D. H.

417. South-west Texas : Subnormal Exploration Yields Few Discoveries. T. F. Smiley. *Oil Gas J.*, 28.1.43, **41** (38), 149.—Twenty-three oil wells and three gas wells were completed in South-west Texas in 1942 out of 319 wildcats, and the small number and general unimportant character of the strikes may cause an increased use of geophysics in this area. South Caesar was an exception as regards importance. Its first production came from the Carrizo at 6552–6557 ft., and this was followed by an extension and a new sand discovery at 6614–6655 ft. Both sands are over 50 ft. thick. Twelve producers and three dry holes have been completed.

During 1942 there were 1026 completions, against 1841 in 1941. The greatest decline in drilling was in the south-central area, which also had seventy-four failures out of ninety-five completions. About a third of the lower Gulf Coast area completion wells were dry in 1942.

The discovery well of the Sarco gas-field gave 180,000,000 cu. ft. of gas on open flow together with 50 brl. of distillate per day.

The Nordheim and Yorktown discoveries in De Witt County did not start a drilling campaign in that region. The first well of a gas-field in Victoria County gave 162,000,000 cu. ft. of gas/day through open tubing. 2 ml. west of the South Sun field distillate and gas have been found in a drill-stem test at 8542 ft.

The cumulative production, 1942 production and the estimated reserves on 1st January, 1943, are listed by fields, together with a summary of the completions. G. D. H.

418. Forest City Basin. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 153.—During the past four years about eighty dry holes have been drilled in the Forest City Basin, but in December 1942 the first deep production was found in the Bartlesville in the centre of Atchison County, Missouri. The well was 1440 ft. deep. During 1942 nineteen dry holes were drilled in Missouri. No important addition was made to the Polo gas-field in Caldwell County. Richardson County, Nebraska, the principal producing area of the Basin, had fifteen new oil wells and nine dry holes, compared with forty-five oil wells and twenty-three dry holes in 1941. Five wells were added to the Dawson pool, three of them finding oil in the Viola. Nine wells were drilled in the Barada pool, which is north of Falls City. G. D. H.

419. Michigan : Exploration Extending North of Present Production. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 156.—Although more oil discoveries were made in Michigan in 1942 than in 1941, most of the new pools were small in reserves. The production record for 1942 was better than for any other year except 1939. The total reserves added in 1942 were about 10,690,000 brl., only half of the 1942 production.

The Evart field was the best 1942 discovery, and it has already provided 169,000 brl. of oil. The Fork field is believed to have good prospects.

One of the most significant exploratory trends in 1942 was the work in the northern part of the State. Three oil areas were opened in Missaukee County, where there had not previously been commercial production. Other fields were developed in northern Roscommon County and in western Lake County. In 1943 there will probably be prospecting still farther north.

The chief feature of 1942 was the opening of commercial production in the deeper horizons of some of Michigan's oil-fields. Five deep areas (Richfield, Headquarters, Norwich, Adams, and Winterfield) are producing, and two others (Enterprise and Foster) have good prospects. Wildcatting to the Traverse failed to give a single major discovery. Richfield and Foster have no upper Traverse or Dundee production.

Tables list by fields the 1942 production, and the cumulative production and estimated reserves on 1st January, 1943, and there is a summary of the 1942 well completions. G. D. H.

420. Eastern Texas : Wood County Paluxy Sand Discoveries Start Big Play. H. F. Simons. *Oil Gas J.*, 28.1.43, **41** (38), 158.—Interest in East Texas was revived in 1942 by the Paluxy discoveries at Coke and Quitman in Wood Country. Coke was opened by a well at 6262–6350 ft., which flowed 920 brl./day initially, and now the pool has twenty-five oil wells. The Quitman field discovery well came in at 726 brl./day. In the Larissa pool the discovery well in the Pettit lime yielded 37 brl. of oil and 65,000 cu. ft. of gas/day from 10,160 to 10,212 ft. Eight wells have been drilled in the Kildare pool, which produces from the Glen Rose at a depth of 5992 ft. The pay section is about 200 ft. thick. The Weiland field has been defined almost completely. Its discovery well came in at 266 brl./day from 2761 to 2773 ft.

About 270 wells were abandoned in the East Texas field in 1942, and only six were drilled. Lack of transport held back the production in the early part of 1942. Salt water injection increased during the year.

In 1943 it is likely that interest will centre on Wood County and on pre-Woodbine zones.

Tables give the 1942 production, and the cumulative production and estimated reserves on 1st January, 1943, as well as the types of completions during 1942.

421. Louisiana Gulf Coast : Gas-Distillate Fields Lead in Importance in Quiet Years. T. F. Smiley. *Oil Gas J.*, 28.1.43, **41** (38), 161.—Thirty-six out of the forty-eight wildcats drilled in the Louisiana Gulf Coast area in 1942 failed, and there were ten oil wells and two gas wells. Only 434 wells were completed—about half of the 1941 total.

A wildcat in Acadia Parish blew out of control in October, and in December it was blowing 523 brl. of distillate and 49,220,000 cu. ft. of gas/day from a total depth of 10,447 ft. A relief well is being drilled. Three miles south-west of Krotz Springs a new gas and distillate pool was opened at a depth of 9316–9326 ft. in December.

The construction of a recycling plant has been begun in the Erath field, Vermilion Parish. Nineteen wells have been completed in the Bayou Sale field, which was opened in 1941. Development has extended southward, and it may join the Bateman Lake field. Gas-distillate production was opened in the extreme south of the field in a new sand at 10,703 ft., and this may be the same sand which produces in the Bateman Lake field.

A new shallow upper Miocene sand has been opened in the Whitelake area of Vermilion Parish, and a new sand at 9567–9572 ft. has given production in the University field. The Bay De Chene discovery well came in 7470–7500 ft.

Tables show by fields the 1942 production, and the cumulative production and estimated reserves on 1st January, 1943, together with a summary of the 1942 well completions. G. D. H.

422. North Louisiana, Arkansas : Large Discoveries Made in Pettit and Smackover Pays. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 164.—Development has shifted north from the Wilcox trend, which was dominant in 1941, to the deeper Pettit and Smackover limes. The 446 completions of 1942 were 44% below the 1941 figure. 60% of them were oil wells.

121 wells were drilled at Haynesville in 1942, and the field was extended into Arkansas. The Midway pool was the most active pool in Arkansas, but it had little drilling at the end of the year. This pool has been defined by dry holes on all sides except the east.

A wildcat in Pope County, North Arkansas, flowed at 26,000,000 cu. ft. of gas/day from sands at 2475–2512 ft. and 2802–2817 ft. A new field, 15 ml. from the nearest production, has been opened in Catahoula Parish, Louisiana. Oil is obtained from the Sparta at a depth of 1810 ft. A good Pettit lime pay was discovered north of the old Carterville pool. The discovery well flowed 400 brl./day from 6029–6122 ft. The Gary field in Sharky County came in at 2400 brl./day from 3263–3265 ft.

The 1942 production, and the cumulative production and estimated reserves on 1st January, 1943, are tabulated by fields, together with a summary of the 1942 well completions. G. D. H.

423. Rocky Mountain Area : Tensleep Production at Elk Basin Is Most Important Discovery of Year. T. R. Ingram. *Oil Gas J.*, 28.1.43, **41** (38), 167.—362 wells were completed in Colorado, Wyoming, and Montana in 1942, 115 fewer than in 1941. 226 found oil and seventy-six found gas. Eleven discoveries were made from twenty-four important wildcats, four being deeper horizons and three gas finds. All of the seven Colorado wildcats were dry, and Montana had two oil and two gas finds out of six wildcats.

In the southern part of the Elk Basin field, Wyoming, deep production was found in the Tensleep. This excellent structure has given 11,000,000 brl. of light oil from shallow pays, and the Tensleep discovery may place it among the State's largest black-oil-fields.

A 580-brl. well was completed in the Dakota at Horse Creek, but later it showed water. This well is on the north-west rim of the Denver Basin, and it may lead to wildcatting in North-east Colorado. A deep Tensleep pay was opened in the Pilot Butte field, and later an Embar discovery was made.

A small Wasatch well was completed in the North Hiawatha field.

The most important discovery in Montana was a Madison lime producer on the Twin Rivers structure north-west of Cutbank. This made only 85 brl./day, but it opens up an area with favourable prospects.

Tables give the 1942 production, and the cumulative production and reserves on 1st January, 1943, by fields, together with a summary of the 1942 completions. G. D. H.

424. Canadian Production at Peak. V. Lauriston. *Oil Gas J.*, 28.1.43, **41** (38), 169.—Canada produced 10,359,267 brl. of oil in 1942. This is a record.

Turner Valley has been extended ½ ml. to the north. It has more than ninety undrilled well locations in proven territory, with good prospects of an extension of the productive area. Ten additional producers have been completed at Vermilion, which gave 66,720 brl. of oil in 1942.

A well at Taber came in at 330 brl./day from a depth of 3181 ft. An 80-brl. well has been brought in at 3180 ft. at Tilley.

The plant for recovering oil from the Athabaska tar sands has now been reconstructed.

Considerable new drilling is understood to have been done at Fort Norman, and 35,000 brl. of oil were obtained in 1942, against 14,119 brl. in 1941. The construction of a pipe-line from Fort Norman to Whitehorse in the Yukon Territory has been considered.

Tables show the oil production by fields in 1941 and 1942, the number of wells producing in January and in December 1942, as well as a summary of the types of completions in 1942. G. D. H.

425. New Indiana Pools Small in Extent. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 169.—No important new oil-field was discovered by widespread wildcatting in Indiana in 1942, although twelve new fields and pay zones were opened, all of them in the south-west of the State. Devonian lime production was found in the Shelburn field, where five wells came in for 150–200 brl./day each initially. In all other instances the results have been disappointing, only single-well pools resulting in most cases.

Much of the 1942 development was in the Hazleton, Griffin, and Caborn fields. Interest in Trenton and sub-Trenton production in North-east Indiana increased throughout the year, and many deep tests were under way at the year end. Two miles east of the old Trenton gas-field two tests have found Trenton lime production. The wells are 1 ml. apart, and gave 120 brl./day. In Adams County a deep test showed oil in the Jordan sand at 2261 ft. The Jordan sand lies well below the St. Peter.

Most of the proven acreage in the older fields has been developed and there are no prospects of increasing reserves in sight. Exploration in the near future will be mainly in the south-west and north-east. G. D. H.

426. Gas Discoveries Take Lead in Ohio. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 170.—Most of the new pools and extensions in Ohio in 1942 were gas discoveries. The Clayton oil-field was extended ½ ml. north by a 55-brl. producer, and westward by three 100-brl. wells. It may possibly join the old East Somerset field 2 ml. to the west. The small Thron pool has been extended ½ ml. to the south-east. There is a possibility of a southward extension of the Hinckley gas-field. The Gaysport gas pool and the Clinton oil-pool were extended during 1942. A new Oriskany sand gas-field was opened in Guernsey County, but it is not expected to be large. No commercial production was found in sub-Trenton tests. G. D. H.

427. The Nation's Major Fields. W. V. Howard. *Oil Gas J.*, 28.1.43, **41** (38), 171.—Over half of the U.S. oil output in 1942 came from fields giving more than 10,000 brl./day. Many of the production declines of the major fields reflect market and transport conditions, and this is particularly noticeable in West Texas. Of the thirty-seven fields listed as having recoverable reserves of more than 100,000,000 brl. of oil, only Hawkins is a recent discovery, and these fields possess more than half of the nation's recoverable reserve.

California, Texas, and New Mexico are dependent on major fields, but Louisiana and Kansas get the bulk of their oil from medium-sized fields. Texas and New Mexico are the only States with more than half of their original reserves still underground.

Tables give the production of the seventy-five major fields in 1941 and 1942, the age, estimated ultimate, and remaining reserves. G. D. H.

428. December Completions Show Gain Over Previous Months. Anon. *Oil Gas J.*, 28.1.43, **41** (38), 205.—1454 wells were completed in U.S.A. in December 1942, 101 more than in November. The Mid-Continent area led in the increased activity, Oklahoma, and Kansas having seventy-eight additional completions, with thirty-two more oil wells. 494 dry holes were completed during December, an increase of fifty-eight over November. California had thirty dry holes. Illinois suffered a decline of thirty-three completions.

A table summarizes the operations in December 1942 by States, showing the total completions, numbers of oil, gas and dry wells, the footage, and the numbers of wells in various depth ranges. G. D. H.

429. Study Reveals Imperative Need for Increasing Nation's Oil Reserves. H. J. Struth. *Petrol. Engr*, January 1943, **14** (4), 31.—In 1942 the U.S. crude oil production was only about 1% below the 1941 figure; the refinery runs were about 5% lower than in 1941. In 1943 it is expected that 1,475,000,000 brl. of crude will be required compared with the 1,385,000,000 brl. produced in 1942. The indications are that not only is the new oil discovery rate insufficient to offset the heavy withdrawals from underground reserves, but the available supplies are being used 22% faster than under the efficient rate of utilization realized in peace-time.

The known U.S. oil reserves have fallen by more than 3,000,000,000 brl. since 1938, and the reserve additions in 1942 were only 55% of that year's production. While the number of wildcats drilled in 1942 was almost the same as in 1941, the number of dry holes was 30·6% of the total, against 22·2% in 1941. The total number of wells was 48% below the 1941 figure. The oil demand is now three and a half times the demand during the last war, when 118,000 brl. of oil were found per dry hole drilled, whereas the corresponding figure for 1941 was 60,000 brl., and for 1942 49,000 brl.

Crude oil prices were practically stationary during 1942, when production fell in Texas, Louisiana, Oklahoma, Illinois, and New Mexico, while it rose in Kansas, California, Arkansas, and the Eastern States. Illinois had a 61% decline in completions and Oklahoma a 57% decline. Texas provided 35% of the nation's 3100 wildcats, and these formed 22% of that State's completions. Illinois had 18% of the nation's wildcats, which constituted 30% of that State's 1942 completions. Only 125 wildcats were drilled in California last year, whereas there should have been twice that number had materials been available. Throughout the nation there were 442 successful wildcats which added 750,000,000 brl. of new reserves.

While the demand for gasoline fell by 67,875,000 brl. in 1942, the fuel oil demand rose by 53,963,000 brl.

In 1938 the discoveries reached a peak of 1,650,000,000 brl., giving total reserves of 21,813,000,000 brl. at the beginning of 1939, but the reserve was only 18,586,000,000 brl. at the beginning of 1943, for the average annual discoveries since 1938 have been only about 500,000,000 brl. Since 1935 the ratio of discoveries to production has declined steadily. The number of dry holes drilled per 1,000,000 brl. of new oil discovered has increased nearly nine-fold since 1935, and the reserves in terms of years' supply have fallen from 19·1 years in 1935 to 12·6 in 1943. In 1935 the average cost per exploratory well was about $31,000 and the cost per barrel of new oil was 13·3 cents, while it took 4·3 exploratory wells to find 1,000,000 brl. of new oil. In 1937 the cost was 6·3 cents/brl. of new oil, but in 1942 the cost/brl. of new oil was 37·6 cents and the average cost per exploratory well was $47,000, eight exploratory wells being required to find 1,000,000 brl. of new oil.

There are eight diagrams and eleven tables giving statistics. G. D. H.

430. Wildcat Drilling in California. W. A. Sawdon. *Petrol. Engr*, January 1943, **14** (4), 100.—Last year a few small fields were discovered in California, and extensions were made to some old fields. Production increased and drilling decreased. Many shallow wells were drilled in proved areas to increase the supply of heavy oil. The light-oil production is not yet at its maximum effective recovery rate, and careful gas conservation is being practised in the light-oil production. Depleted oil-fields are being used to store excess summer-gas production for use in the winter.

During the period 1939–1942 the discovery of new fields and the extensions to proved areas were not enough to maintain the known reserve. The number of exploratory wells declined in this period, and was restricted last year by material shortages as well as by economic factors.

The Riverdale field, discovered at the end of 1941, came in at 6665–6685 ft. for 558 brl./day of 34° A.P.I. crude, with 1,375,000 cu. ft. of gas. Lower zones tested wet. The Williams field gave 1725 brl./day of 16·5° A.P.I. oil from 2340 ft. in the discovery well which later went over to water. The Williams field is a sharp anticline with a productive area of less than 1000 acres. The deeper zones, such as the Wagon Wheel and the Eocene, have not yet been tested.

The Anaheim–Buena Park area discovery well came in at 9660 ft. Two wells have been completed, but one is giving much water. The Paloma field has been extended 1 ml. to the north by a well which gives 34·4° A.P.I. oil instead of 50–55° A.P.I. oil as in the high gas–oil ratio area. The new well was drilled to 11,043 ft. The Aliso Canyon field has been extended to the west by a 9086-ft. well, of which the initial production was estimated to be 2393 brl. of oil/day with more than 1,000,000 cu. ft. of gas. The oil is from the upper Lusian rock with closure against a fault.

A new field may have been found east of the Strand field. The discovery well was drilled to 8207 ft., and initially gave 1553 brl./day of oil and 1,250,000 cu. ft. of gas. Very heavy oil was found on the Rancho Corral de Quatti, north of Los Olivos, and this oil has to be thinned with distillate to permit pumping it to the surface. The structure is anticlinal with the oil in fractured siliceous shales (Miocene).

The Bowerbank field discovery well produced 11,000,000 cu. ft. of gas/day from 4253–4262 ft. G. D. H.

431. Future Development of North-west Wilmington Field. W. R. Cabeen and A. L. Hunter. *Oil Gas J.*, 4.2.43, **41** (39), 60.—Marked changes in stratigraphy in going from the Wilmington field north-west towards Torrance, coupled with complicated faulting and flattening of the structure, influence the amount of vertical and horizontal oil saturation in the North-west Wilmington field. Therefore the possible recovery from each part of the area must be estimated separately. Block A, the most north-westerly fault block, has 136 ft. of producing sand in the Ranger and Terminal zones, each of which has an average porosity of 15% and an average saturation of 75%. Block B, the next fault block to the south-east, has 467 ft. of producing sand in all, with similar porosities and saturations to Block A. Block C, still farther to the south-east, has 90 ft. of producing sand in the main Tar zone, which has an average porosity of 30% and a saturation of 85%. The Terminal and Ranger

zones have similar properties to those of Blocks A and B. The Ranger and Terminal oils have gravities of 16° and 18–20°, respectively.

In North-west Wilmington the recoveries range 250–400 brl./acre-ft., depending on the local sand conditions and the relation to other wells. The recoveries per acre range 25,000–75,000 brl. These figures are based on a five-acre spacing, which seems to be best from an engineering and economic standpoint. The present ten-acre spacing may not drain the field adequately. On a ten-acre spacing the maximum that the field could yield in its first flush production year would be under 2,000,000 brl., assuming that there are 650 undrilled productive acres to be developed. The actual figure is likely to be well below this because of time and supply difficulties.

G. D. H.

432. Possibilities of the Cotton Valley Formation in Arkansas. C. H. Thigpen. *Oil Gas J.*, 4.2.43, **41** (39), 62.—The Cotton Valley series and the Smackover lime have been the two main objectives in most of the Arkansas wildcats since 1936, for the overlying formations have been thoroughly tested and their possibilities fairly well exhausted. The Cotton Valley formation includes dark shales, limestones, and sandstones at Cotton Valley, but is a red series at Schuler. Its northern edge runs through the middle of Hempstead, Nevada, Ouachita, Calhoun, and Bradley Counties, and it attains a thickness of 2400 ft. at the Arkansas–Louisiana State line.

The first Cotton Valley production in Arkansas was obtained in April 1937 in the Schuler field at 5500–6000 ft. The producing sand (Morgan) was lenticular. In September 1937 production was found at the base of the Cotton Valley in the Jones sand. The original reserve was estimated at 56,000,000 brl., and 146 wells have been drilled.

At the beginning of October 1942 the Arkansas Cotton Valley pools were giving about 19% of the State's production. Cotton Valley wells have been completed at Dorcheat and Macedonia, but these are closed in at present. Generally the producing horizons in the Cotton Valley formation are lenticular and irregular. Frequently the lenses do not cover the whole pool. At Schuler the producing zones are at 5500 ft., 6900 ft., and 7500 ft. Several oil and gas-distillate zones are indicated at Dorcheat and Macedonia down to a depth of 8000 ft.

The original reservoir pressures were approximately normal for depth, but as the sands are lenticular the flowing life of most Cotton Valley pools will be short, due to the lack of effective water-drive. Up to the beginning of 1943, 181 Cotton Valley wells had given 29,000,000 brl. of oil, 25,500,000 brl. being from the Jones sand of the Schuler field. Sand porosities range 15–25% and permeabilities range 200–2000 millidarcys.

Two cross-sections, a stratum contour map, and a table giving data about the Cotton Valley pools are included. G. D. H.

433. Analysis of P.A.W. Estimates Confirms Previous Conclusions. W. V. Howard. *Oil Gas J.*, 11.2.43, **41** (40), 26.—The P.A.W. estimates of reserves discovered in 1942 amount to 144,697,980 brl. in the drilled parts of new fields, and in undrilled parts there may be a further 172,411,332 brl. of reserves. The possible maximum is 516,744,349 brl. New pay horizons found in 1942 may give reserves of 104,018,740 brl., with a possible maximum of 284,114,280 brl. Thus the maximum possible estimate of reserves from 1942 discoveries and new pays is only about 60% of the output for the year.

The reserves of fields found during the period 1935–1940 inclusive amounted to 160–300% of the estimates made at the end of the year in which they were discovered. Hence the P.A.W. estimated maximum possible reserve for 1942 discoveries is in line with experience during recent years.

P.A.W. gives 261 new fields and seventy-four new pays for 1942.

Regardless of the number of commercial or near commercial discoveries made in 1942, it now appears that only five can be considered as important fields. These are Square Lake, New Mexico; Pauls Valley, Oklahoma; Midway, Arkansas, and Coke and Quitman, East Texas. G. D. H.

434. Possibilities of Smackover Limestone in Arkansas. C. H. Thigpen. *Oil Gas J.*, 11.2.43, **41** (40), 85.—At Smackover the Smackover formation consists of 700 ft. of

dense to oolitic limestone. In the south of Arkansas the upper part of the formation is oolitic to chalky, and the lower part dense with argillaceous bands. The Smackover dips south-west at about 85 ft./ml. Its thickness ranges 450–900 ft. in Arkansas, and at Rodessa it is 1230 ft.

The first Smackover lime production was obtained in April 1936. Numerous Smackover lime structures have been located by seismograph, and Smackover lime-pools were opened at Schuler and Buckner in 1937; Magnolia, Village, and Atlanta in 1938; Dorcheat and Big Creek in 1939; McKamie in 1940; Macedonia and Mount Holly in 1941; and Midway, Texarkana, and Columbia in 1942.

At the beginning of 1943 Arkansas' Smackover lime pools were producing about 48% of the State's total output, and some 70% of the prorated output. Thus the Smackover is Arkansas' most prolific producing horizon.

The Smackover lime pools in Arkansas are generally symmetrical anticlines, elongated east–west. The fields are 1–1½ ml. wide, and the largest, Magnolia, covers 4500 acres. Nine of the fields give 32–45° A.P.I. gravity oil, while six produce gas-distillate of 52–70° A.P.I. gravity. Usually the gas has a high H_2S content, and is very corrosive. The production control allows effective water-drive. The gas/oil ratios are about 300 cu. ft./brl. in under-saturated pools, 750–1250 cu. ft./brl. in saturated pools, and 10,000–30,000 cu. ft./brl. in gas-distillate pools. The reservoir porosities range 14–20%, and the permeabilities 50–1500 millidarcys.

Only three of the twenty-nine Smackover wildcats drilled in 1942 were successful, and gave the Columbia, Midway, and Texarkana fields. New London was the only Cotton Valley find, apart from dual completions and reworking at Macedonia, Dorcheat, and McKamie.

Tables give the Smackover fields with discovery date, depth, number of wells, oil gravity, and cumulative production; the thickness of the Smackover limestone at various points and the thickness of the two constituent members; the porosity, permeability, and oil and gas reserves. A map shows the structure of the top of the Smackover limestone. G. D. H.

435.* Compaction and Some Oilfield Features. G. D. Hobson. *J. Inst. Petrol.*, February 1943, **29** (230), 37–54.—Compaction of sedimentary rocks is studied analytically in the light of Ortenblad's equations, which are used to deduce the following inferences: (1) For sediments of identical grain size, but for different rates of sedimentation, those being laid down most slowly will be most compact. (2) After sedimentation ceases the hydrodynamic pressure at a given point—*i.e.*, the pressure component driving liquid from the sediment—and also the porosity at that point decrease with time, comparatively rapidly at first, and then more and more slowly. As the hydrodynamic pressure decreases the intergranular pressure increases correspondingly. (3) At a given reduced depth the porosity in a thick deposit will be greater than at the same depth in a thinner deposit, until compaction ceases. The paper discusses the following variables: porosity, permeability, reservoir pressure, fluid movements, the time of oil formation as compared with the time of sedimentation and compaction, and finally closure as developed by compaction over buried hills. The paper is well illustrated and is detailed in treatment. A. H. N.

Geophysics.

436. Radioactivity and Geochemical Well Logging. L. C. Uren. *Petrol. Engr*, January 1943, **14** (4), 50.—Measurements of the radioactive emanations from the strata exposed in a well permit the distinguishing of shales, sands, limestones, salt, anhydrite, etc. These measurements are recorded at the surface while the instrument which detects the emanations is in the well. The recorded intensities give patterns which may permit correlation between wells. This type of logging can be carried out even when the formations have been cased off.

Adsorption phenomena and the compaction of sediments under water may be responsible for the fact that shales usually exhibit greater radioactivity than sands and sandstones.

The detecting instrument consists of an ionization chamber suspended on an electric cable. The chamber contains a gas of high molecular weight, and above it

is an amplifier. Current flows in the circuit only when the ionization chamber is influenced by radioactive emanations, and the current is proportional to the emanation intensity. In making the log the instrument is drawn upwards from the bottom of the well.

The recorded variations in the lateral position of the radioactivity profile are only relative, and lack quantitative significance. Low radioactivity is shown by sand, sandstone, or limestone, while clay and shale give a high intensity. The logs do not indicate the porosity and permeability of the rocks or the nature of the fluids the rocks contain, although the indication of clay or shale naturally implies low permeability. Thin clay streaks can easily be detected, and unconformities and faults may be shown. The position of the bottom of the casing or of the cement plug is clearly shown. Open hole logs give rather better differentiation and more detail than logs from cased holes. The presence of fluid in the well does not affect the logs. Possible oil-sands can be detected behind casing, and this feature is useful for wells drilled before electrical logging was introduced. Well logs may be checked.

In neutron logging the formations are bombarded with neutrons generated from radioactive material in the surveying instrument, and the intensity of the gamma rays so produced is measured by an ionization chamber above the part of the instrument carrying the radioactive material. The method may be able to show the porosity and the fluid content of the rocks, for hydrogen nuclei have a special action on the neutrons.

Delicate methods of chemical analysis allow the presence of minute amounts of hydrocarbons, hydrogen, etc., in rock samples to be determined quantitatively, and on plotting the values so obtained against a depth scale, a geochemical well log results. Often the patterns are characteristic, and they may indicate the presence of oil or gas accumulations in underlying or nearby beds. Thus the probable success or failure of a well can often be predicted before it is completed.

Within geological time slow migration of hydrocarbons has occurred through the beds overlying oil deposits. Thus even surface soil may show minute amounts of hydrocarbons. Systematic soil analyses may show a "halo" of hydrocarbons around an oil deposit. In geochemical well logging the sampling intervals depend on the detail required, but are commonly about 30 ft. Cores or drill cuttings may be used. A complete analysis gives hydrogen, total hydrocarbons, methane, methane–butane, pentane–decane, carbonate, sulphate, halides, and acid-soluble sand. The source of the hydrogen is uncertain. The methane may not be from an oil accumulation. The hydrogen maximum on the logs generally occurs above the oil, commonly several hundred to 1000 ft. above, and then the amount of hydrogen diminishes rapidly nearer the oil. The total hydrocarbons increase with depth, and show a rapid rise as the oil is approached. When oil is present the pentane–decane content is high; when gas alone is present the content of methane–butane is high. The advance indications of the presence or absence of oil or gas facilitate completion planning, and prevent premature abandonment. Dry holes generally give low hydrocarbon values. If the well is off-structure the hydrocarbon values show a maximum and then decrease at greater depths. G. D. H.

437.* The S.P. Dipmeter. H. G. Doll. *Petrol. Tech.*, January 1943, **6** (1), A.I.M.M.E. Tech. Pub. No. 1547, 1–10.—The S.P. dipmeter consists of three electrodes set 120° apart in a horizontal plane when the instrument is vertical, and connected through separate insulated conductors to potential measuring devices at the surface, with the circuit closed through the earth and a ground electrode. Above the electrodes, and always in the same relative position, is the photoclinometer, consisting of a compass needle and a ball free to set in its equilibrium position on a graduated glass of known curvature. A camera is so situated that it photographs the needle, ball, and a marker showing the position of one of the electrodes.

When a formation is not bedded in planes at right angles to the axis of the borehole, the three S.P. curves obtained simultaneously will be substantially alike in form, but not alike as regards the depths of particular features. These depth discrepancies correspond to, and are a measure of the dip of the boundary plane separating two beds, and coupled with the orientation of the electrodes and the inclination of the well as shown by the photoclinometer, provide data whereby the dip and the strike of the beds can be calculated or determined on a special instrument.

Normally the dipmeter-photoclinometer is lowered in the hole to 10–15 ft. below the desired section, the S.P. curves being observed all the way down, to make sure of the movement of the instrument. The latter is then pulled up to about 3 ft. below the section, stopped, and after allowing the instrument to settle, a picture is taken by the photoclinometer. When this has been done, the section is surveyed by the three dipmeter electrodes. At the upper end of the section a second photoclinometer picture is taken to find whether the instrument has rotated while being pulled upwards. A series of observations of this type can be taken in a single run.

An example of an actual measurement is given in detail.

Dip measurements can be made in the above manner cheaply, easily, and quickly. Good results are obtained with dips over 10°, and fair results with dips between 5° and 10°. The measurements are valuable in permitting the detailing of structures, and are very useful in the investigation of salt dome structures. G. D. H.

438.* Use of Neutron Curves. A. B. Winter. *Oil Wkly*, 25.1.43, **108** (8), 20.—The neutron type of radioactivity well logging measures the effect of the bombardment of the formations by neutrons from a strong source. Neutron logging seems to be of value as a companion curve to the gamma-ray logging, and used alone to solve certain subsurface problems regarding the formations behind casing. The effect of the neutron bombardment is measured in an ionization chamber situated above the neutron source. The source of neutrons in the logging instrument is a mixture of radium and beryllium, and most of the neutrons are fast and penetrating. The neutrons are able to pass through many inches of iron without much loss, and they are slowed down mainly by the hydrogen present in the rocks.

The logging device is connected by cable to recording apparatus at the surface, and the average surveying speed is 1000 ft./hour. Satisfactory logs can be made with or without fluid in the hole, but the position of the liquid level relative to the zone of interest should be known accurately, for the presence or absence of liquid in the hole shifts the curve as a whole. Dense limestones or hard sandstones give high intensity values on the curve. Oil or water in the pores shows the occurrence of porous zones in limestones or in clean sandstones by giving low intensities. Shales also give low intensities generally, due usually to the greater amount of hydrogen in the shale, either as connate or chemically combined water. Consideration of gamma-ray and neutron logs together permits shales to be detected by their high gamma-ray intensities and low neutron log intensities. The position of the casing seat is usually shown clearly on neutron logs.

A neutron and a gamma-ray log are given, together with the corresponding well log. G. D. H.

Drilling.

439.* Making the Most of Drilling Materials. J. S. Montgomery. *Oil Wkly*, 7.12.42, **108** (1), 14–16. *Paper Presented before American Association of Oilwell Drilling Contractors.*—The paper describes, in a general manner, precautions to be taken with drilling equipment and methods of maintaining them for longest use under efficient conditions. The life of drill-pipe varies with areas in which it is used, as some areas encounter formations which develop a very corrosive fluid, and the drill-pipe deteriorates before the tool-joints are worn out. Other wells encounter abrasive formations in which the tool-joints are worn and the drill-pipe is in good condition. There are services companies making satisfactory internal inspection of drill-pipe to advise when joints of pipe should be laid down or the entire string laid down. Experience indicates that this service has been satisfactory. Where pipe is worn out from corrosion, tool-joints should be salvaged and used on other pipe. It would appear that a programme would be most applicable whereby tool-joints in corrosive areas would be transferred to pipe used in abrasive areas, thus reducing the requirement of purchasing new tool-joints. It is, of course, appreciated that some types of tool-joints are not salvageable. The outside wear of tool-joints has given a great deal of concern to rotary operators, and reports are made of the building up of tool-joints by welding on a hardening material. However, it seems that the most practical method to-day is to apply a sleeve to the tool-joint. Where tool-joint threads are worn and the body of the joints is still in good condition, it is very practical to turn new threads. Un-

even wear on tool-joints may be attributed to crooked drill-pipe. Above all other things, an operator should be very careful in seeing that his drill-pipe is straight at all times, or he may expect undue wear which will be first noticeable by uneven wear on the pipe and the tool-joints.

There has been some experience in building up and in re-sleeving drill-collars. However, this experience so far leaves some question as to its success. Where bits have not been badly worn, and their bearings are in good condition, there is every reason to have them re-tipped, as they have proved satisfactory in most operations. The greatest care that can be exercised on the kelly joint is to see that it is straight at all times and properly handled in moving from one location to another. A. H. N.

440.* Improved Casing Recovery Method Reduces Cost. W. L. Baker. *Oil Wkly*, 21.12.42, **108** (3), 16.—The method consists of making a series of cuts at pre-determined intervals with one trip into the well, then going in with a washover string and recovering each section of cut casing without withdrawing the string from the hole. When the recovered casing is being removed, the washover pipe is suspended from slips, and the casing is withdrawn through it. This method of recovering casing from dry holes has the following advantages over methods formerly used: (1) Rig time spent in breaking down and picking up the wash pipe is very greatly reduced. (2) Rig time is further reduced by making all the cuts before washing operations are started. (3) The rental on wash-pipe and special tools is reduced through decreased rig time. (4) There is less expense of conditioning mud due to the smaller number of trips into the hole and the shorter time required for the entire operation. (5) More casing can be recovered at a cost equivalent to or less than the value of the casing.

Examples are given for five wells where the method was used. The procedure recommended may be summarized as follows: (1) Select as large an interval between cuts as is feasible, taking into account the quantity of wash-pipe available and the clearance between the casing collars and the original walls of the hole. An interval up to 1000 ft. for 5½-in. casing and up to 500 ft. for 7-in. casing is suggested. (2) Run a cutting tool and cut the casing a short distance above the theoretical top of the cement. Make additional cuts progressively upward at the predetermined interval. (3) Make up the string of wash-pipe slightly longer than the interval between cuts, run an overshot between the top and the next to top joint. (4) Wash over the casing until the overshot will latch over the top collar. Then pull the pipe up until the overshot is above the rotary table, break the joint between the overshot and the balance of the wash-pipe, and set the wash-pipe on slips. (5) Pull the casing through the wash-pipe, break it out and lay it down, then screw the top of the wash-pipe back on the overshot, and proceed to wash over the next section of casing. A. H. N.

441.* Progress in Drilling. Anon. *Oil Gas J.*, 31.12.42, **41** (34), 142.—The paper is written in English and Spanish, and reviews drilling practices in 1942. One of the principal advances in drilling concepts during the past year was the increasing importance placed on the necessity of drilling the bore-holes to gauge. It has become increasingly evident over the past few years that many of the major troubles of drilling and production operations have been due to this factor. For instance, investigation in one case of a deep well, which was bothered extensively by twistoffs at 2000–2700 ft., showed that washouts of the hole in this interval were allowing the drill-pipe to assume an eccentric and whipping motion. Mud conditioning to prevent erosion and dissolving of the shale in this section eliminated twistoffs.

Troubles with casing failures have on numerous occasions been due to this cause. This is principally due to the fact that when the cement was placed back in the pipe, the presence of a cavity allowed the cement to channel. It has also been found that there was sufficient cavitation of the formations to affect greatly the height of the cement behind the pipe.

Mud problems are reviewed in some detail. The greatest advance in the handling of drilling fluid, and one of major importance as far as drilling in general is concerned, has been the development during the past year of a satisfactory treatment for the reduction of the water loss and filter-cake in salt-water contaminated fluids. The main ingredient required is an organic colloidal material. The material (Impermex) is a special organic colloid which is added to the drilling fluid containing salt. The salts (calcium, magnesium, sodium) in the fluid are a partial preservative, but it is necessary to add other chemicals to prevent growth of organisms which will cause the

mud to lose some of its desirable properties. The application of this material and the results to be obtained with it have been known for a number of years, but there were numerous details concerned with its use which were not thoroughly understood. One of these was the souring or fermentation of the drilling fluid. The hydrolyzed starch material would be added, and the desired results obtained. After a few days the water loss would again increase and the drilling fluid would get steadily worse. It was found that bacterial action caused fermentation—something not formerly experienced when using inorganic drilling fluids.

Now that the fermentation can be prevented by addition of recently developed preservative chemicals, it is possible to take a salt-water drilling fluid with a water loss of 150 c.c., treat it with the organic compound, and bring the loss down to 10–12 c.c. It can be brought even lower if desired. From 2–5 lb. of the commercial material barrel of drilling fluid is the amount used. The cost of the material is reasonable in view of the results obtained.

Slim-hole drilling and multiple-zone completion are reviewed. At the end of the paper the interesting method of disintegrating mud cake—which is found to be negatively charged—by applying electricity to it, through the use of casing as an electrode, is briefly discussed. A. H. N.

442.* Electrical Logging to Determine Character of Formations. L. C. Uren. *Petrol. Engr*, December 1942, **14** (3), 46.—The development of electrical logging methods is first given. Resistivity measurements are then discussed. In comparing the electrical properties of rock strata exposed in the wall of a well, a system of electrodes, lowered into the well from the surface on a multi-conductor cable, is employed as a means of establishing a flow of electricity into each stratum, whereas the relative conductivities of different beds are determined by measuring the inverse values of their relative resistivities. The electrode system usually comprises three electrodes suspended at different depths, a few feet apart. One electrode is used as a means of passing direct current through the intervening well fluid into the surrounding strata. The other two electrodes, connected through a potentiometer at the surface, record a certain difference in potential which, considered in relationship to the spacing of the electrodes, the temperature, and the conductivity of the well fluid, indicates the resistivity of the formation immediately surrounding the input electrode.

The electrode system is slowly lowered into the well, and a continuous record showing variation in resistivity as indicated on the potentiometer is automatically recorded on photographic film in the form of a profile on a depth-scale that can be directly compared with a driller's graphic log of the well. Values of resistivity are expressed in ohms/cu. m. of rock mass, and range from as little as one to several thousand ohms, depending on the electrical conductivity of the material. The factors influencing the conductivity are discussed.

When a liquid is forced through a porous solid medium, a difference in potential between two points in the porous solid is observed. Thus, drilling fluid filtering through the porous rock strata exposed in the wall of a well develops an electro-filtration effect that creates an electro-motive force that may be measured by the single-electrode circuit described. Also, an electro-motive force is generated whenever two different electrolytes come into contact in water solution in a porous medium: as when drilling fluid enters a permeable stratum from the well and develops contact with the native fluid in the formation. The electro-motive force developed increases as the interfacial surface of the fluid in contact increases, and inasmuch as this interfacial surface of contact increases with the depth of penetration of the drilling fluid into the formation, it follows that a greater electro-osmosis effect is developed in highly permeable strata than in those less so. Electro-filtration e.m.f. and electro-osmosis e.m.f. both result from migration of drilling fluid into the wall rocks, and, as migration occurs more readily and to a greater degree in highly permeable strata than in those less so, it follows that the observed values of the self-potential generated become a measure of the relative permeabilities of the formations that give rise to them.

The equipment of electrical logging, together with the application and interpretation of this method, are discussed at length.

In discussing the future of the method, Prof. Uren points out that the art of electrical logging is young and many opportunities for its further development and application doubtless still exist. Up to the present time, electrical logs have been used primarily

in making relative comparisons of rock properties. The data have been regarded as having only qualitative value. Yet it would seem that the resistivity and self-potential records should have quantitative significance, and that if we had sufficient information, or understood them well enough, we could begin to interpret them in terms of actual sand permeability, porosity, oil or water content. Perhaps, also, they will find new applications, as in determining the depth of penetration of drilling fluids, the effective thickness of clay wall-sheaths, proximity of wells to edge-waters, location of unconformities, gas-oil interfaces in gas-cap areas, etc. A new method of obtaining electrical records while drilling is in progress, by making the logging equipment a part of the regular drilling "string," has been proposed and partly developed. Present methods of electrical logging are applicable only in open hole, but some way of procuring resistivity and self-potential records through casing or outside of casing may yet be developed, using perhaps more complex circuits in which the casing plays a part—such as that employed by the "stratagraph."

Twenty-nine references are appended. A. H. N.

443. Directional Redrilling of Piercement Type Dome to Increase Recovery. J. Zaba. *Oil Gas J.*, 14.1.43, **41** (36), 31–33.—The method of directional drilling of wells for oil is studied. The practical application of the method may be divided into three groups. The first group includes cases in which directional drilling is used as an emergency measure. The best example of this application is directional drilling of a relief well to control a burning or a cratered well. The second group covers application of directional drilling as a development measure. In this group would be included drilling of multiple wells from one surface location, completing of a well under an inaccessible location from a satisfactory surface location, drilling in highly faulted areas, and other similar cases. The third group comprises application of directional drilling for the purpose of securing additional oil recovery from apparently drilled-out properties. In this application directional drilling is used with particular success in the old piercement-type salt-dome fields of the Gulf Coast. Considerable additional recovery is being obtained in this area in fields which were considered as drilled out with normal development methods.

Directional re-drilling of a property appears to violate the generally accepted concept of advantages of wide spacing. It should be remembered, however, that a re-drilling campaign, to be economically successful, can be applied only in special cases, and that piercement-type dome oil-fields constitute just such a special case. The producing area of such fields is usually a narrow rim surrounding the salt mass. Steep dips, faulting, and abrupt lateral changes of the lithological character of the producing formations make the location of the bottom of the well of primary importance. Conditions encountered are illustrated by the case of a well drilled in one of these fields. The problems to be studied are explained. A. H. N.

444.* Effects of Certain Gums and Starches on Filtration of Salt-Water Muds at Elevated Temperatures. F. Perkins and B. C. Craft. *Petrol. Tech.*, January 1943, **6** (1), A.I.M.M.E. Tech. Pub. No. 1551, 1–4.—It is important to control filtration or water loss from drilling muds, for this affects the analyses of side-wall cores, the interpretation of electric logs, and the amount of cementing needed. Salt-water and/or high temperatures seriously affect the filtration characteristics by increasing water loss, a trouble which can be reduced by adding starches and gums to the muds. In testing the effects of adding gums and starches the viscosities were measured in a Stormer instrument at 600 r.p.m., and water loss in a Baroid wall-building tester at 80–250° F. under a pressure of 500 lb./in.^{2} for 30 min. The mud was formed of 150 gm. of commercial Louisiana mud, 50 gm. of salt and 300 gm. of tap water. Gelatinized starch (1% caustic soda, 10% dry starch and 89% water) or gum was added with stirring to give a mud viscosity of about 50 centipoises. In the fermentation tests germicides such as trichlorophenol and pentachlorophenol were added.

The most favourable amounts of gum karaya, gelatinized starch, commercial starch, and gum ghatti (0·25%, 1·0%, 1·5%, and 1·0% respectively) gave filtration rates less than a quarter of those for the untreated muds, and with a much smaller increase of water loss with rise in temperature. The effectiveness of the two starches increased greatly above 175° F. Gum-treated samples had much better filter cake textures than those treated with starch. The addition of more than 0·25% of gum

karaya gave very high viscosities. More than 1·5% of commercial starch markedly increased the mud viscosity.

Gums karaya and ghatti had slight fermenting tendencies, while muds with commercial starch fermented under all conditions except when germicides were added. Commercial starch seems best for field use since gums are too expensive under present conditions. Germicides should always be added except with gelatinized starch in highly alkaline muds. G. D. H.

445. Patents on Drilling. A. G. Bodine. U.S.P. 2,304,793, 15.12.42. Appl. 9.6.41.—Method and apparatus for cutting pipe.

D. G. C. Hare. U.S.P. 2,304,910, 15.12.42. Appl. 29.5.40. Determination of specific gravity of fluids whilst passing through containers, such as pipes, etc.

W. L. Church and R. R. Crone. U.S.P. 2,305,062, 15.12.42. Appl. 9.5.40. Cementing plug for well-casing.

A. P. Heldenbrand. U.S.P. 2,305,079, 15.12.42. Appl. 10.9.38. Pipe-thread cleaner with rotating brush.

H. W. Sitton and T. H. Sitton. U.S.P. 2,305,200, 15.12.42. Appl. 25.2.41. Drilling tool with two drills, one solid and the other tubular.

M. M. Kinley. U.S.P. 2,305,261, 15.12.42. Appl. 23.11.40. Method of removing pipe from wells.

P. W. Lange and H. A. McFarland. U.S.P. 2,305,624, 22.12.42. Appl. 22.4.39. Power-driven pipe-tongs.

G. D. Johnson. U.S.P. 2,305,709, 22.12.42. Appl. 8.7.40. Releasable pin tap for engaging in an object in wells.

R. E. Wiley. U.S.P. 2,305,944, 22.12.42. Appl. 23.9.40. Inclination indicating device having a suspended marking element capable of universal movement and clock mechanism.

A. J. Penick and K. T. Penick. U.S.P. 2,306,102, 22.12.42. Appl. 17.2.41. Casing head.

A. H. Graham. U.S.P. 2,306,118, 22.12.42. Appl. 20.3.41. Earth-boring device having a tool with cutting flights of different diameters.

S. W. Long. U.S.P. 2,306,130, 22.12.42. Appl. 27.3.40. Well-drilling apparatus having bushings with central openings for the drill pipe.

L. R. Brown. U.S.P. 2,306,368, 29.12.42. Appl. 25.6.40. Cementing tool for oil-well cementing.

D. D. Anderson. U.S.P. 2,306,369, 29.12.42. Appl. 22.9.41. Coring apparatus with a central core-barrel.

W. B. Noble and J. F. Shaw. U.S.P. 2,306,491, 29.12.42. Appl. 15.6.40. Core-bit with rotary cutters.

W. B. Noble. U.S.P. 2,306,492, 29.12.42. Appl. 23.11.40. Reamer in a well-forming tool.

P. Talmey. U.S.P. 2,306,509, 29.12.42. Appl. 2.10.39. Gas detector using heated wires covered with catalysts.

M. D. Carleton. U.S.P. 2,306,522, 29.12.42. Appl. 18.5.40. Drilling apparatus having roller cutters.

D. M. Smith. U.S.P. 2,306,647, 29.12.42. Appl. 9.2.42. Kelly-driver assembly in combination with a rotary machine.

A. R. Maier. U.S.P. 2,306,739, 29.12.42. Appl. 24.4.41. Locking mechanism for well-drilling rotary.

A. S. Volpin. U.S.P. 2,306,838, 29.12.42. Appl. 2.11.40. Slush-pump piston with removable packing and ring.

G. D. Johnson. U.S.P. 2,307,275, 5.1.43. Appl. 24.1.41. Drilling safety joint for oil-well drilling.

P. W. Appleby. U.S.P. 2,307,658, 5.1.43. Appl. 13.10.41. Well-washing tool with rotary cutters.

C. J. Haynes. U.S.P. 2,307,887, 12.1.43. Appl. 28.12.39. Rotating contact device to be used as a borehole electrode.

W. M. Hamon. U.S.P. 2,307,927, 12.1.43. Appl. 6.11.40. Jar with rotatable and longitudinally telescopic elements.

P. H. Granger. U.S.P. 2,308,072, 12.1.43. Appl. 27.5.41. Method of cementing oil-well casings.

J. C. Ballagh. U.S.P. 2,308,147, 12.1.43. Appl. Protector for drill-pipes and the like.

A. E. Cuthrell. U.S.P. 2,308,157, 12.1.43. Appl. 8.4.38. Derrick supporting member with extensive undersurface.

L. G. Howell. U.S.P. 2,308,176, 12.1.43. Appl. 1.2.41. Operations in boreholes consisting of placing materials in the wells, each material containing radioactive materials of short and different life, this to be used in locating the materials.

W. G. L. Smith and A. M. Graham. U.S.P. 2,308,316, 12.1.43. Appl. 17.7.41. Drill-pipe protector assembly.

R. E. Fearon. U.S.P. 2,308,361, 12.1.43. Appl. 10.11.38. Well-logging method and device. Using a neutron-emitting source.

C. L. Fox. U.S.P. 2,308,652, 19.1.43. Appl. 13.8.40. Oil-field derrick or the like structure.

W. P. Bulkley and J. E. Gough. U.S.P. 2,308,743, 19.1.43. Appl. 16.9.39. Barge for supporting well drilling equipment.

E. H. Olmstead. U.S.P. 2,309,004, 19.1.43. Appl. 28.10.40. Oil-well-logging winch-truck.

P. L. Phillips. U.S.P. 2,309,210, 26.1.43. Appl. 3.8.40. Platform supporting means to be used in derricks.

H. A. Raphael. U.S.P. 2,309,211, 26.1.43. Appl. 4.7.39. Rotatable dial for determining amount of weight on formation.

E. Ventresca and A. Ventresca. U.S.P. 2,309,225, 26.1.43. Appl. 19.12.41. Wire line pipe cutter to be used in severing stuck pipes.

J. G. Gratehouse. U.S.P. 2,309,310, 26.1.43. Appl. 23.1.41. Overshot for engaging and withdrawing an object in a well-hole.

C. A. Lundeen. U.S.P. 2,310,246, 9.2.43. Appl. 5.10.40. Pipe-tong with a multiple-size jaw.

M. Hokanson. U.S.P. 2,310,288, 9.2.43. Appl. 17.7.39. Drill-bit of a detachable two-piece type.

M. Hokanson. U.S.P. 2,310,289, 9.2.43. Appl. 23.10.39. Drill-bit for rotary well drilling.

A. P. Sullivan. U.S.P. 2,310,472, 9.2.43. Appl. 12.10.40. Gas analyser using a combustion cell and a comparison cell.

N. W. Wickersham. U.S.P. 2,310,483, 9.2.43. Appl. 1.3.40. Well-cementing apparatus.

H. A. Raphael. U.S.P. 2,310,597, 9.2.43. Appl. 13.4.40. Carriage-type weight indicator.

E. E. Blondean. U.S.P. 2,310,611, 9.2.43. Appl. 23.12.38. Electrical exploration of geological strata by borehole logging. A. H. N.

Production.

446.* Duplex Power Pumps for Oil Field Service. F. B. Applegate. *Petrol. World*, October 1942, **39** (10), 28.—This part of the paper (to be published in three instalments) deals with the design of duplex pumps. The major factors affecting the design

of pumps of all types are the characteristics of the materials used in their construction and the characteristics of the liquid to be pumped. The strength, casting, or forging properties of a material, its behaviour under stress, and its resistance to corrosion, affect both design form and design proportions of pump parts. The physical characteristics of the liquid to be pumped affect the design form as well as some of the design proportions parts in contact with the liquid. The chemical characteristics of the liquid, *i.e.*, whether it is corrosive or non-corrosive, affect the selection of the materials from which parts in contact with the liquid are to be fabricated. The strength, endurance, efficiency, and economy of a pump depend on the skill and ingenuity of the engineer in co-ordinating these factors when developing his design. A review of the more important characteristics of materials and liquids is made, to show their effect on the design of duplex pumps. The discussion includes brief notes on the metals used and on the viscosity, vapour pressure, and corrosion characteristics of the liquids to be met on an oil-field. The gearing of the pump, particularly the characteristics of herringbone gear, is studied.

Since oil-field pumps are designed primarily for pumping crudes at or slightly above atmospheric temperatures, it is evident that viscosity and capacity must be correlated in determining the design, form, and proportions of a liquid cylinder. Because the viscosity of a crude is a measure of its resistance to flow, and because power must be expended in overcoming this resistance, it is apparent that the power required to overcome viscous friction will depend on the area, form, and length of the liquid passages in the cylinder. For a given quantity of oil at a given viscosity, a reduction in the area of a liquid passage of as little as 10% may increase the resistance to flow as much as 90%, and an abrupt turn will offer from three to eight times the resistance of a long radius bend. Since the power expended in overcoming unnecessary resistance is an economic loss, it is necessary for the designer to use the utmost skill in developing " stream-line " cylinder passages of the most efficient area for the design capacity.

Viscosity and capacity affect the area of the liquid valves, particularly the suction valves. To be efficient, a valve must have sufficient area to assure a smooth, unrestricted flow of liquid to and from the piston chambers of the cylinders, and it must have a minimum differential area to reduce to the minimum the pressure required to open the discharge valve. The ideal pump-valve would be one having a knife edge seat and zero differential area, which is impractical. The design engineer must display considerable skill in developing a valve that will nearly approach the ideal.

A. H. N.

447.* Disposal Plant for Waste Water. J. H. Collins. *Petrol. World*, November 1942, **39** (11), 32.—New filtering process at Santa Fe Springs treats waste water, following oil separation by gravity, and completely purifies it. The requirements are: (1) oil, nil; (2) turbidity, 50 parts per million, or less; (3) hydrogen sulphide, one part per million, or less; (4) colour, clear; (5) odour, none objectionable. The paper describes in brief the research which went into the development of the plant and a certain amount of its economics. The plant cost $750,000, and its yearly maintenance and overhead charges are $100,000. The oil in the water is separated and sold.

A. H. N.

448.* A Method of Approach to Determine the Economics of Pressure Maintenance. N. van Wingen. *Petrol. World*, November 1942, **39** (11), 45.—In this paper a description is given of one possible method of determining the economics of a primary recovery, or pressure-maintenance operation, as applied to a deep, high-pressure, low-permeability reservoir. The primary intention is to attempt to demonstrate to what extent a consideration of relative increased recoveries for operations under various degrees of pressure maintenance need be predicated in order to justify economically pressure maintenance operations. The economics of four methods of exploitation for a given field are considered in the analysis: (1) Natural depletion method of operation. (2) Pressure maintenance operation, involving the return to the reservoir of only a portion of the solution gas produced, thus permitting some gas sales (partial pressure maintenance case No. 1). It has been assumed, in this instance, that during the life of the project 50% of the solution gas produced will be returned to the reservoir, thus permitting some gas sales after allowing for plant fuel and shrinkage. (3) Pressure

maintenance operation where gas, in addition to that produced, will be returned to the reservoir (partial pressure maintenance case No. 2). (4) Complete pressure maintenance. The problem is worked out in full. A summary of the data shown in a table, indicates that net profits increase in almost direct proportion to the amount of gas returned to the reservoir, to an extent that a purchase of "make-up" gas, which is necessary in order to achieve the higher degrees of pressure control, appears to be profitable. It is apparent from the tabulation that the increased revenues obtainable as gas injection volumes are increased, and derive from the correspondingly greater oil recoveries which were estimated. For the second part of the investigation an estimate was thus made in which the recovery for all degrees of gas returned was assumed to be the same as for the natural depletion method of operation. These data are again tabulated. It is apparent from this tabulation that the net profit on this basis is essentially the same irrespective of the manner in which the field is to be produced. Hence, any increased oil recoveries obtainable under pressure maintenance essentially represents merely a proportional amount of additional income, so that even though the increased profit may be less than is indicated in the table given, progressive additional revenues should result for higher degrees of pressure maintenance operations.

These considerations would seem, then, to resolve the entire problem of determining the economics of pressure maintenance operations to a consideration of the following: Determination of increased recoveries for various degrees of pressure maintenance, as against deferred sales for the gas, including a consideration of the economic feasibility of purchasing gas for injection purposes. It is emphasized, in conclusion, that the foregoing calculations have been predicated on the assumption that it will be possible to control the expansion of the secondary gas-cap, so that no significant by-passing of the recycled gas will take place. In any actual field problem, careful consideration should be given to this factor, as it is undoubtedly one of the most critical ones on which the success of primary gas-injection schemes is contingent. A. H. N.

449.* Performance Factors in Pump Operations. F. B. Applegate. *Petrol. World*, November 1942, **39** (11), 56.—The effects of various properties of the liquid on the performance of the pump are studied. After certain fundamental terms are defined and evaluated, the effect of viscosity is studied. If a pump is operating at its maximum rated speed and a viscosity for which it is designed, any decrease in the viscosity of the oil will not affect the speed or the capacity. If a pump is operating below its maximum rated speed and the viscosity of the oil is decreased, the speed of the pump may be increased and the capacity increased in proportion to the speed. However, in no case should the increase in speed exceed the maximum speed for which the pump was designed. The effects of an increase in the viscosity of the oil are not so easily determined. An increase in viscosity will increase the friction losses in the suction and discharge lines, and the magnitude of these losses will govern the speed-capacity change. With the existing condition of suction-lift or suction head, if the increase in the friction losses are sufficient to reduce the capacity of the suction line, the capacity of the pump must be reduced in proportion to the reduction in suction capacity. This may be accomplished either by reducing the speed of the pump or by installing smaller lines and pistons in the liquid end. The friction losses in the discharge lines should be checked to determine the effect of increased viscosity on the discharge pressure and the horse-power required to drive the pump under the changed conditions.

The effects of vapour pressure are studied. The vapour pressure is important in conjunction with the vacuum created in the cylinder. When a liquid containing gas in solution is brought into a vacuous space, the gas will expand and fill a part of the space. It is difficult to calculate the exact volumetric expansion of gas in the suction, because it depends on the time the liquid remains in the vacuous space. This time is a function of the quantity of liquid, diameter, and length of the suction line. Other factors are the amount of gas in solution and the suction lift. However, calculations can be made which, if not accurate, will indicate if the volumetric expansion of the gas will affect the performance of the pump under certain conditions of suction lift. The total pressure required to force a liquid into the piston chambers of a pump is the sum of: (1) The pressure required to overcome the friction in the suction line. (2) In case of suction lift, the pressure required to support the weight of the liquid

in the suction line. (3) The pressures required to overcome the entrance losses to the suction line, the inertia of the liquid, the pressure required to accelerate and maintain the rate of flow and to lift the suction valves from their seats.

The pressures for 1 and 2 are variable, and their value should be calculated for each case. The pressures required for 3 are quite small, 0·6 being sufficient for a full diameter suction line and a properly proportioned suction valve. The foregoing outline of the basic principles of pump suction emphasizes the necessity of avoiding suction lift whenever possible. If it cannot be avoided, every effort should be made to keep it to the minimum. A. H. N.

450.* Maintenance of Electric Motors in Wartime. E. Sterrett. *Oil Wkly*, 7.12.42, **108** (1), 17.—Many hints are given on the maintenance of electric motors. Tables are also drawn describing symptoms and cures for different types of troubles. Field motors are being equipped wherever possible with overload protection, and even, in locations where the known loading imposes temporary power peaks above the unit rating, with recording devices whereon is shown the actual motor temperature during each cycle of operations. Overload units, formerly remaining inoperative over periods of years under normal conditions of operation, are checked at frequent intervals to determine their accuracy and reliability, and fuses are calibrated against their ratings to insure against overloading or overheating a motor through excessive capacity of safeguards.

Reduction of load in certain types of drives has been found to introduce a type of motor trouble due to underloading instead of the opposite. Where reduced production on a well cannot be cared for by intermittent pumping, an induction motor may be underloaded to the point where the wattless current—that used in producing the magnetic field in the motor—is out of balance with that energy required to produce mechanical energy. Thus power factor, or ratio of real power to total power, is lowered. At underload, the induction motor is operated under a few disadvantages: it has higher line losses, higher voltage drop, and loses torque. This condition increases the load on the power line—a serious matter where purchased power is used, and results in higher energy/unit of work done. The motors tend to overheat and damage windings, due to the excessive current set up by the high proportion of wattless current carried. This is one of the conditions which may be indicated by excessive motor temperatures, especially when a change in operating conditions has lowered the actual work done by the motor. A. H. N.

451.* Recoveries Obtained Under Different Extraction Methods in Various Fields. Part 1. S. F. Shaw. *Oil Wkly*, 7.12.42, **108** (1), 25.—Different fields in the U.S.A. are studied and their recovery figures compared. Production methods and policies are outlined. The case of Powell field is interesting because of the conclusions reached in connection with well-spacing. The recovery/acre-foot at Powell was considerably higher than the general run of recoveries in fields discovered later in Texas. After the flush production was over, water-drive continued to wash the oil out of the sand, and aided materially in increasing the recovery. In July 1929 daily average production of liquid of one major company was 324 brl./well, of which 93% was water. In the later life of the field operation it became chiefly a matter of lifting large quantities of water to recover small quantities of oil, and continued operation was dependent entirely on the cost of lifting the large volumes of water, and on the price of oil. Casing sizes were 7-in. in the majority of wells, and 2½-in. tubing was employed, and during the flush production the oil was produced through the casing.

Thickness of sand in the Powell field is assumed as 45 ft. by engineers of the Bureau of Mines. With assumed porosity of 25%, the original void content is 87,273 brl./acre. This does not represent the quantity of residual oil present, since no allowance is made for gas content, temperature of the oil, connate water content, or degree of saturation, such as is attempted at the present time in making such estimates. With total recovery to the end of 1941 at 44,300 brl./acre, or 985 brl./acre-foot, which does not allow for the oil used in boilers in the field, nor for pipe-line deduction of 3%, and without taking into account the presence of gas or connate water content, the recovery is slightly above 51%. In the East Texas field, where the depth is about 3600 ft., the shrinkage factor is 0·8 to 0·7, and if 0·8 be applied tentatively to the Powell field, the recovery would be 63¾%, or 66% when pipe-line deduction and fuel

loss are considered. If connate water be assumed at 20%, the recovery would reach 82½%. Hill and Sutton state: "The above figures make it evident that recovery in the Powell field has been exceptionally high (based on about 50%), bearing out the theories that a high gas pressure, rapid development, and close spacing are the prime factors governing the ultimate production/acre."

Other fields are studied, with similar details. It is considered that up to the present facts are often mixed with "opinions and propaganda" to a large extent, and thus no final conclusions can be reached about the best methods of producing such a large field as the East Texas, for instance.

The paper is long and detailed. A. H. N.

452.* **Problems in Selecting Proper Materials for Oil-Well Pumps.** W. H. Jackson. *Oil Wkly*, 14.12.42, **108** (2), 15–18.—With the ever-increasing depth of new wells drilled, the extremely high pressures encountered have made it necessary to secure the very best materials possible to insure that "fittings" would stand up under these working pressures, since the limited space in which they are assembled requires that they be made of steels with heat-treating qualities. In many instances, pressures exceeding 2000 lb./sq. in. are exerted against fittings or parts having a wall thickness of less than ¼ in. The steels from which these fittings are made are of the nickel, chrome, molybdenum, and both high and low-carbon type, and often a combination of two or more types, depending on their position and use in the pump, whether in compression or tension in their relation to each other.

A breakdown of the types of pumps divides them into two distinct groups. First, the original design is known as the tubing pump, so named from the method of its installation at the bottom of, and lowered into, the well on the string of tubing. The plunger assembly is run through the tubing to its proper position in the barrel on the string of rods that actuates the movable parts of the pump when in action. The second is the rod type, since this pump is installed and removed in its entirety on the rods, making it less costly to pull for replacement or repairs. Each type is discussed separately and its problems are briefly analyzed. A. H. N.

453.* **Recoveries Obtained Under Different Extraction Methods in Various Fields.** Part 2. S. F. Shaw. *Oil Wkly*, 14.12.42, **108** (2), 22.—Since curtailment has become so general, the thought has become widespread that restricted extraction rates and wide spacing result in a greater recovery of oil. If this be the case, estimates for ultimate recovery/acre should be higher in fields found since 1930 than in those developed several years prior to 1930, particularly when the greater propulsive force generally found in the deeper reservoirs developed since 1930 is considered. In this part of the paper a further number of fields are studied in a similar manner to that adopted in the first part, and comparisons are made.

In order to make valid and close comparisons of ultimate recovery between different fields, it is first necessary to ascertain closely the approximate oil contents of the reservoir. This involves a knowledge of the sand thickness, porosity, saturation, connate-water content, and gas content. While progress is being made in measuring the factors, much remains to be done along that line, and in the older fields these factors are not obtainable to any degree of satisfaction. As wells reach to greater depths, the reservoir pressure is higher, and there is usually a greater quantity of gas dissolved in the oil, and the increased pressure and gas content increase the probability of obtaining a higher ultimate recovery than in the more shallow sands; on the other hand, the greater gas content tends to reduce the quantity of oil/acre contained in the reservoir, other factors remaining the same.

It is clearly recognized that a comparison between recoveries/acre without considering these other factors is subject to criticism; yet if the aggregate recovery from a sufficient number of fields in the same general area is compared with that from a number of other fields in the same area, but with different methods of production, it remains to be seen whether the comparison will go far wrong. The great difference in methods of operation between fields discovered in early days with those discovered since 1930 lies in the much closer spacing and in more rapid withdrawals in the earlier fields. The writer has endeavoured to recite the actual conditions applying to the various methods of producing oil in the fields listed, and his own conclusion at this time is that when producing through bore-holes, capacity methods and close spacing

for the most part result in maximum recovery. The reader may interpret the conditions and results differently. Only the passing of time combined with a careful study of the results actually achieved will determine the correctness of the conclusions.

While the writer is of opinion that the evidence points to the conclusions stated, he by no means believes that a profitable outcome should be subordinated to high ultimate recovery; therefore it would seem as if the sane policy to pursue, when there is a large producible excess of supply over demand, is to restrict production and to space wells so that a profitable outcome will result. On the other hand, when the demand requires that more oil be produced, spacing should be closer, and rates of production up to the maximum should be extracted. A. H. N.

454.* Reworking and Sidetracking Oklahoma City Wells. N. Williams. *Oil Gas J.*, 17.12.42, **41** (32), 33.—(Part of the paper is cut out by the censor. Enough remains for understanding the main points.) It has become fairly well established that there exists in the reservoir of the Oklahoma City Wilcox sand-pool a condition in which fluid levels have experienced a substantial recession. This is attributed to the absence of an active hydrostatic head, and consequent failure of water movement into the reservoir to keep pace with withdrawals during a long period of the field's flush productive life. With the exhaustion of gas energy and the natural rock pressure of the reservoir, the remaining water and oil have been permitted to seek new levels in accordance with their respective volumes, thus creating the phenomenon of gravity drainage of oil down-structure.

For the time being it appears that the water level is more or less stabilized. There has been no change in the water-production status of the field for a considerable time, with water withdrawals remaining almost constant at about 14,000 brl. daily. This indicates that the daily withdrawals are about balancing the ingress of water into the reservoir. Recession of the oil level, however, continues in direct proportion to the oil withdrawals. This is creating a steadily thickening void in the top of the sand, spreading down-structure as the fluid level drops. In turn, the oil level has dropped below the respective producing depths of wells at successively lower structural positions, and the productive capacity of the wells and leases has steadily declined. With the limits of economic production at their respective existing depths reached, many such wells and leases have been abandoned or shut down. Prior to conception of the phenomenon of receding fluid levels it was believed that the productivity of these wells and leases was at an end, even though many were located at up-structure positions normally favourable for prolonged production. However, in the light of present knowledge of reservoir conditions, which has resulted from studies and work done by the Oklahoma City Wilcox Pool Engineering Association, the way is open for reclamation of many of these wells and leases by deepening the wells or re-drilling to lower points in the sand which might still be below the oil level.

Working over and re-drilling of old wells and reclamation of old leases constitute an active phase of work in the Oklahoma City field at this time. Results are proving highly successful. A large number of wells, some of which had been abandoned or shut down for some time and others the production of which had apparently dropped to about the point of exhaustion, have already been re-completed as good producers. In many cases entirely new wells have been drilled on old leases which had been considered depleted, although this type of work is limited due to war restrictions on new drilling in proved areas and difficulties of obtaining equipment and materials for that purpose. With few exceptions all these re-completions and new wells have come in good for from 250–700 brls. daily of sustained production with little or no water. Re-working and re-drilling work now in prospect is expected to play an important part in bolstering the field's daily output and ultimate recovery and forestalling premature abandonment of many leases. A. H. N.

455.* Concrete Blocks for Pumping Counterweights. E. Sterrett. *Oil Wkly*, 28.12.42, **108** (4), 17.—To allow for the increase in bulk required for replacing steel (or iron) counterweights of the riding type by concrete, it is necessary to allow for the fact that concrete weighs approximately 150 lb./cu. ft., as compared with 460 for cast iron, and thus 3 cu. ft. or more of clearance space must be allowed for one taken up by the iron counterbalance. This question of clearance has led to the use of hanging or swinging weights on many pumping units where the ground clearance permits

such a plan. The concrete is cast into a rectangular block, or sometimes is simply shovelled into an oil-drum, the desired stirrup or supporting bolts placed before the concrete hardens, and the finished weight slung from a chain, hook, or link or other flexible attachment at the end of the beam.

Unless provision is made to guide this counterweight in a vertical plane during the working cycle, it frequently develops an oscillating action which imposes severe and often wrecking force on the pumping unit. Methods for curbing this side-sway range from casting pipe-guides in the weight, and the installation of properly placed slides for these to work over, to the provision of trunnion bearings at some point near the centre of mass of the weight, and the use of spacer bars to give the weight a prescribed vertical path of motion. Mechanical details are discussed at length.

Just as the operators found that the weight-box, whether filled with scrap metal, rock, sand, or gravel, required adequate drainage provisions to prevent the effective loading from being materially changed by prolonged rainy spells, so have they learned that the concrete block is much like a sponge in its tendency to absorb water and then to evaporate it. Concrete will take up as much as 30 lb., or 20%, during a long rainy period. Again, if a rain-soaked block be shifted to give proper balance, that same concrete, following a long dry spell, may fall under weight sufficiently to throw the well system so far off balance as to introduce damaging stresses. Severe winters may result in partial destruction of the blocks. Methods of water-proofing blocks are discussed. A. H. N.

456.* Oil Reservoir Behaviour Based Upon Pressure-Production Data. H. C. Miller. *Oil Wkly*, 28.12.42, **108** (4), 23.—This forms a reprint of an extensive Bureau of Mine's Report of Investigation (No. 3634) and is illustrated by many typical examples. The graphic method for exhibiting reservoir-pressure and oil-production data discussed in this report, where the cumulative decline of reservoir pressure (in lb./sq. in.) is plotted as ordinates on a logarithmic chart against cumulative recovery (in barrels) as abscissas, appears to have advantages in analyzing pressure-production data on petroleum reservoirs. By this method the relation between cumulative decline of reservoir pressure and cumulative recovery can be represented on a logarithmic chart by straight lines for large increments of liquid recovered. For some reservoirs one or two, and for most reservoirs not more than three or four, interconnecting straight lines will exhibit the pressure decline–oil recovery relations for their entire producing lives. The lines have different slopes, and the slope angles, when studied in conjunction with the physical characteristics of the oil and the type of reservoir, are shown in the report to reveal whether the source of energy driving oil through the sands and porous rocks to wells is the result of gas expansion, a combination of gas expansion and water-drive, or solely a natural water-drive.

As a change in the rate of oil production (or in gas–oil ratios for water-drive reservoirs in which the source of energy is the expansion of gas or a combination of gas expansion and water-drive) affects the efficiency of utilization of reservoir energy and is reflected in the size of the slope angle, the relative efficiency of oil-producing methods in a given reservoir can be determined by comparing the slope angles before and after a change in operating procedure. If the slope angle, after a change in field operating methods, is smaller than before the rates of oil withdrawal or gas–oil ratios were altered, the efficiency of utilization of reservoir energy must have increased, as the small slope angle indicates the recovery of a larger quantity of oil/unit decline of reservoir pressure. It does not necessarily follow, because decreasing slope angles mean increasing efficiency of utilization of reservoir energy under certain conditions, that a slope angle of 0° indicates maximum efficiency of recovery of oil from a reservoir. A change in the relation between cumulative decline of reservoir pressure and cumulative oil recovery from one exhibiting a positive slope angle on a logarithmic chart to one of 0° only indicates that the expansion of gas in the reservoir has been replaced by a natural water-drive. In general, however, a water-drive is a more efficient oil-motivating agent than gas expansion, and a reservoir in which a water-drive has operated throughout its producing life will usually yield more oil ultimately than if part of the oil had been recovered as a result of gas expansion. Nevertheless, in all reservoirs in which the oil moves through the sands and rocks as a result of a water-drive, the rate of advance of the water is a factor in the efficiency of oil recovery. Although a fairly rapid rate of water movement may permit the recovery of more oil

than an exceedingly slow rate, edge-water will "finger" into an oil reservoir if the rate of encroachment is too rapid, and by-pass oil that might have been recovered if the rate of water movement had been slower.

The slope angle for gas-driven pools—gas-expansion being the immediate source of energy—should be about 45°. Water-drive alone is denoted by a slope of 0°. Mixed drives will have intermediate slope angles. A. H. N.

457.* The Laws of Gas-flow in a Gas Reservoir. Part 1. E. N. Kemler. *Oil Wkly*, 21.12.42, **108** (3), 26.—The laws governing the flow of a compressible fluid such as a natural gas are somewhat different from those for a liquid. In the case of a liquid, the volume of the fluid is essentially constant, and is independent of the pressure over the range of conditions encountered. The flow of a natural gas follows the gas laws over a considerable range of conditions, and within the limits of accuracy of other data can be considered as following them over the range of operating conditions to be studied. In the case of flow in reservoirs, the temperature of the reservoir, and hence the gas, will be constant, and so-called isothermal or constant temperature conditions can be assumed. For this condition the general relation for rate of flow as expressed in terms of the physical properties of the fluid, reservoir, and pressures will be :

$$Q = \frac{2\pi kb}{P_\theta \mu \log_e \frac{r_d}{r_w}}(P_m^2 - p^2) = \frac{C}{P_\theta}(P_m^2 - p^2).$$

The corresponding formula of flow of a liquid in a reservoir as given in a previous article was :

$$Q = \frac{2\pi kb}{\mu \log_e \frac{rd}{r_w}}(P_m - p) = C(P_m - p),$$

where k = permeability, b = sand thickness, $g = 32{\cdot}2$, μ = viscosity, r_d = drainage radius, r_w = well radius, P_m = closed in reservoir pressure, p = pressure at well bore, Q = flow rate in cu. ft./day at pressure P_θ.

Professor Kemler does not consider the variation of the permeability of rocks to gas with the pressure of the gas or its rate of flow, but, working on a constant value of permeability, evaluates the effects of increase in back-pressure on the rate of flow. The paper further deals with the calculation of bottom-hole pressure from top-hole pressure. It is graphically illustrated, and three references are appended.

A. H. N.

458.* Trends in Production Practices. Anon. *Oil Gas J.*, 31.12.42, **41** (34), 157.—The paper is written in English and Spanish, and reviews the most important advances made in production in 1942. Steam-raising for power generation and hydraulic pumping are first briefly reviewed. A new instrument for measuring the instantaneous and sustained load on a sucker-rod string has been developed. The principal element is a magnetic strain gauge run on the bottom of the sucker-rods and a magnetic oscillograph at the surface. The complete unit consists of the magnetic strain-gauge control-box with filter, the recording and indicating instruments, and a supply of electrical current. The principle is the transformation of small displacements in the sucker-rods into the reading on an electrical instrument. The instrument was designed originally to determine the load on the sucker-rod string just above the pump. Two of the instruments were used in the field for 6 months, testing wells. A check of the instruments at the conclusion of the test showed that the calibration had not changed.

Electrical chlorination of salt water for disposal is reviewed, together with repairing and cleaning casing perforations by explosives, subjects on which the *Abstracts* 1942 may be consulted. Similarly, the storage of liquid hydrocarbons in depleted formations and multiple-zone productions are treated.

By placing the acid in the desired zones, the efficiency of an acidizing operation can be increased. Previously the carrying out of such a plan has been very difficult, because there was no way of telling into which portion of the formation the acid was entering. The use of a new tool, the electric pilot, now allows greater control while

acidizing. It permits the introduction of the acid into the desired portions of the pay formations, while preventing it from entering the undesirable pay section. The tool is run on the bottom end of the tubing string, and an electric meter at the surface indicates whether the pilot is immersed in acid or oil. The electrical hook-up of the pilot is such that an electrical circuit is completed when the pilot is immersed in a conductive fluid, such as acid, but the electric circuit is not completed when it is immersed in a non-conductive fluid, such as oil.

In making treatments using the electric pilot, it is the general practice to pump acid down the tubing and simultaneously pump oil down the casing. By varying the acid and oil pumping rate, it is possible to maintain the level of the top of the acid at any desired point in the well. As the pilot has previously been placed in the well at the point where it is desired to maintain the top of the acid, the reading on the electrical instruments at the surface will immediately tell where the top of the acid is, and the respective pumping rates of the acid and oil can be adjusted in order that the acid level will be at the desired point. A. H. N.

459.* Rate of Withdrawal, Its Effect on Water Encroachment in the East Texas Field. J. N. Miles. *Petrol. Engr*, December 1942, **14** (3), 33. *Paper Presented before American Petroleum Institute.*—The time of the appearance of the first water and its rate of increase is dependent on several factors, such as sand thickness, penetration, oil-water interface, permeability, shale leases, and rate of production. An operator has no control over most of these factors, and consequently must apply his efforts to those over which he has some control, such as penetration and rate of production. Most of the wells in East Texas have been completed for several years, and they may have been drilled deep into the producing sand or only a few feet. If the penetration is in the order of 10 ft. or more, the opportunity for a successful plug-back job is good, and should be given serious consideration. The rate of fluid production is another important means of controlling the rate of water encroachment, and the factors involved in this criterion in Texas fields are discussed.

The principles of water-coning and in maintaining proper production rates to avoid such troubles are outlined, together with the use of chokes. Two types of bottom-hole chokes are used. One is the tubing type, in which the choke is screwed into the tubing string below the pump. The other is a removable type that is attached to the standing valve or insert pump and can be pulled with the rods. In both cases a packer is employed between the tubing and casing. The tubing is perforated between the choke and the standing valve, which permits the annular space between the tubing and casing to be used as a storage chamber. In this way a choke size can be chosen that will limit the withdrawal from the formation to a few brl./hour, whereas fluid from the annulus can be produced at a rate of 20 or 30 brl./hour. In addition, the rate of withdrawal is not affected by a pumper in need of some quick production.

The choke size is very important, and consideration should also be given to the well capacity or productivity index, rate of withdrawal desired, pump depth, and size of casing and tubing installed. A study is made of choked and unchoked wells.

The main conclusions of the paper are: (1) In areas where water underlies the oil in the same sand the rate of production affects the rate of water encroachment into the well bore. (2) The rate of production can be held to a minimum in both flowing and pumping wells by the use of surface or bottom-hole chokes. (3) In the East Texas field the additional production/well from the use of bottom-hole chokes may be as much as 10,000 brl. of crude oil. A. H. N.

460.* Gas-Lift Technique Employed in Trinidad Wells. S. P. King. *Petrol. Engr*, December 1942, **14** (3), 84.—The tubing-disc choke, perhaps the most important innovation in Forest Reserve gas-lift practice during the last year, has solved several local production problems and increased the overall efficiency of many gas-lift installations. The performance of this flexible and economical type of bottom-hole bean has been so satisfactory that it is now a standard item in the majority of wire-linen operated surface-controlled installations, and in all differential pressure-operated flow-valve installations. The geology of the field and the gas-lift technique employed are discussed, followed by a study of the tubing disc. When the well ceases flowing naturally, either an intermittent unit or the pressure differential controlled flow-valve system is used, depending on conditions. If the latter, a tubing-disc choke

is always included in the design. Inasmuch as these valves operate through the back-pressure existing in the tubing, anything, other than the fluid in the tubing, exerting back-pressure will naturally decrease the amount of fluid lifted and at the same time usually increase the gas–oil ratio. Therefore, if the well is to be beaned to obtain a given rate of trouble-free production, the beaning must be done in such a manner that it creates little or no back-pressure in the tubing opposite the valves. If the well is beaned below the point of injection of the input gas, the back-pressure resulting from beaning is eliminated and the efficiency of the system is improved by utilizing all the available energy in the gas. Because these valves have full opening through the mandrel, an installation of this type can be equipped with a removable bottom-hole choke. Obviously this type of choke is used whenever available. The Otis removable bottom-hole choke is perhaps the best known of its type. The problems met are discussed.

To determine the correct size of disc-choke for a particular installation, it is necessary to have the following well information : (1) Static bottom-hole pressure must be known. (2) Productivity index should also be known. (3) Desired daily rate of production must be decided on. (4) Estimated working fluid level with available working casing pressure must be ascertained. The method is explained by solving a typical problem in full. A. H. N.

461.* Application of Recording Fluid-level Gauge to Oil Production. L. C. Halpenny. *Petrol. Engr*, December 1942, **14** (3), 133.—The applications of the instrument in gauging oil wells, in determining potentials, and in studies of pumping wells are discussed. In connection with pumping wells, it is used in the stock-tanks, and is found to reveal evaporation losses when the pump is stopped. The type of instrument used by the writer is one that has been used for years in the measurement of water behind dams, in irrigation ditches and canals, at river-gauging stations, and to record fluctuations in water level in wells. It consists of an horizontal cylindrical drum covered with a chart, and revolved by a cable attached to a float and counterbalance, and a pen or pencil moving horizontally along the drum and controlled by a clock. In gauging oil production, the float is controlled within the tank by being enclosed in a stilling well, to keep the float directly beneath the sheave attached to the drum, and to minimize false readings caused by waves and foam in the tank. The pen or pencil slides along two polished rods, and is attached by a flexible wire to the clock at one end and to a counterbalance at the other. As the clock unwinds, the counterbalance pulls the pen or pencil along the guide-rods, making an horizontal line on the chart on the drum. If the fluid level is rising, the line produced will be diagonal, as the drum will revolve slightly. Various combinations of gears are available for both the time element and the fluid-level element, so that the graph produced can be of any scale desired. The writer found that a time scale of 0·2 in./hour and a direct fluid-level scale (1 in./in.) were satisfactory for most tests. For tests lasting a week, a time scale of 0·05 in./hour has been found satisfactory. The circumference of the drum is 1 ft., and if the fluid level in the tank rises several feet during a test, the drum merely continues to revolve, and the graph produced will be a series of parallel diagonal lines.

An adjustable stand was developed for use on lease-tanks. It is made from light bed-rails for the frame, and of ¾-in. pipe and sucker rod for the telescoping legs. It is possible to adjust the legs to produce a level surface on a sloping tank roof, and also to raise or lower the frame barely to clear the open hatch. The stilling well is made from sections of 6-in. stove-pipe, the top section of which has two shelf brackets attached, so that it will hang vertically in the tank opening. Additional lengths of stove-pipe are attached with sheet-metal screws as needed to adjust the depth of the stilling well to the height of the tank being measured. A. H. N.

462.* Underground Gas-storage Project in California. W. A. Sawdon. *Petrol. Engr*, December 1942, **14** (3), 138.—The reasons for the project are outlined ; briefly, they are fluctuation in supply and demand, and conservation. The proved producing area of the portion serving as a reservoir is 310 acres in extent, of which approximately one-half is held by the Union Oil Co. ; the other half, a town-lot area, is controlled by about 200 small lease and royalty holders who are scattered over the country. There

are nineteen producible wells on the Union Oil Co. property and eighteen on the town-lot area. Approximately one-half of these are now on production.

There appears to be no actively encroaching edge-water in the field. Depletion has been due almost entirely to gas-expansion, and it is believed that the reservoir sands originally containing oil and gas are still free from encroaching water. The original reservoir pressure at an average mid-point of the reservoir was 2750 lb./sq. in. and the temperature 235° F. The bottom-hole pressures at the beginning of the storage project were as low as 30 lb./sq. in. in some places. By laboratory tests the porosity of the sand was found to be 26% and the permeability 500 millidarcies. The interstitial water was estimated as 25% of the pore space. Using these factors and taking into consideration reservoir characteristics, correction being made for temperature but not for possible reservoir shrinkage due to encroaching edge-water, it was calculated that a gas storage of 2,000,000,000 cu. ft. would be provided by the 20,428 acre-ft. of sand estimated as effective for storage.

The actual volume available for storage is probably half as much again, but the 2,000,000,000 cu. ft. is believed to represent a volume of gas that may be stored and withdrawn with pressure conditions under which it is practicable to operate the project. The equipment required is briefly described. A. H. N.

463. An Electrical Device for Analyzing Oil-Reservoir Behaviour. W. A. Bruce. *Petrol. Tech.*, January 1943, **6** (1), A.I.M.M.E. Tech. Pub. No. 1550, 1–13.—In the mathematical analysis of well and reservoir flow problems, the porous continuum of a reservoir is divided into small blocks of such a size that for a material balance on the fluids in a block an average pressure for the block can be applied. Instead of analytically solving the equations so formed, electrical units can be constructed which will behave in respect of the flow of electricity exactly as the reservoir units behave under various conditions of fluid flow. The electrical units are then wired together in the same way that the reservoir units are connected naturally by virtue of their geometrical locations and shapes.

The fluid-flow equations and the analogous electrical equations are briefly discussed for a single phase compressible fluid, a water-drive unit, an oil zone unit, and for gas flow.

The application of the electrical analyzer to a study of the performance of the Dix pool is described in some detail. Diagrams compare the electrically determined pressure contours with the observed pressure data at different dates in the life of the pool. Fair agreement between observed pressures and the analyzer results was observed.

The apparatus is capable of solving the water-drive problem of any reservoir performance for which a mathematical solution has been presented in the literature, either on the basis of steady or unsteady-state flow analysis. It should be capable of solving reservoir-performance problems previously thought too difficult for practical solution by mathematical means. G. D. H.

464.* Many Benefits Make Gas Return Project Exceptionally Profitable. J. C. Albright. *Oil Wkly*, 4.1.43, **108** (5), 14–18.—The paper discusses the operations in a particular field in the East Burbank Extension of Oklahoma, with the aid of graphs and statistics on production. Several interesting conclusions may be reached from a study of this gas-injection programme. It is apparent that the project is not a re-pressuring operation, but something resembling re-cycling, the success of which depends almost entirely on the sweeping action of the injection gas passing through the sand body to drive the oil from the pore spaces to the well. This is substantiated by the fact that when the volume of gas injected declines, even for a single day, a similar drop is quite noticeable in the production of both gas and oil the following day.

The entire property has shown a gratifying increase in (1) oil production, (2) gravity of oil produced, and (3) production of natural gasoline. As the decline curves show, the properties under a normal-expectancy decline curve should have produced only 315·58 brl. of oil/day in July 1942, if operated under conditions existing before gas injection was started. Instead the producing wells pumped an average of 599·38 brl./day, an increase of 253·80 brl., or 90%. Pumping time has been reduced materially, reducing fuel cost and wear on equipment. Indications at this time point to an increase of 1,500,000 brl. in ultimate recovery of oil above the normal expectancy, all of which can be credited to the gas drive. A. H. N.

465.* Closing High Gas-Oil Wells and Allowable Transfer A Success. F. Brigga. *Oil Wkly*, 4.1.43, **108** (5), 22.—In June 1942 the Texas Railroad Commission granted operators of the Goldsmith field, Ector County, permission to utilize their leases into 16-well tracts, shutting in as many as eight wells in each of these units, and assigning the allowable of each shut-in well to another well in the unit. The purpose was to conserve the physical energy of the field, and thus tend to obtain greater ultimate recovery. The plan has been remarkably successful, and attests to the advisability of shutting in excess gas and water producers and transferring the allowables to other wells. The purpose of the unit production plan was to eliminate the excess gas production from wells that were producing with high gas–oil ratios, thus tending to maintain the bottom-hole pressure. By so doing, the field, which previous to the adoption of the unit plan was producing as an incomplete gas-driven structure, was put in the category of an almost completely gas-driven pool, and thus greater ultimate recovery is anticipated. The paper discusses the advantages accruing from this practice, and gives long excerpts of the rulings of The Texas Railroad Commission and certain amendments to the rulings on this question. A. H. N.

466.* The Application of Build-up Pressures to Calculating Capacity and Reservoir Pressure For Gas Well. E. N. Kemler. *Oil Wkly*, 4.1.43, **108** (5), 28.—This paper may be taken as a continuaton of a series of papers by Professor Kemler on the study of production of wells, appearing in the *Oil Weekly* in 1942 (see Abstracts of 1942). The principles discussed here are the same as those discussed in Part 3 (not Part IV, as mentioned in references at end of paper). In the previous discussion formulæ for oil wells were studied: For gas wells it is possible to derive expressions that can be used to determine the reservoir pressure from data taken over a short period. The method can also be used to give an idea as to the capacity of the well to produce. Such methods are particularly adaptable to wells of relatively low permeability or productivity-index factor. When the permeability is low, the time required to reach full reservoir pressure may involve many days, and in some extreme cases may require a month or more to reach the true equilibrium condition. For such cases it is obvious that a means for determining the reservoir pressure from data taken over a short period would be very helpful.

The use of the open-flow method of determining well capacity has the disadvantage of wasting gas. Open-flow tests for establishing actual well-producing capacity under various conditions are not very reliable, particularly in wells of relatively low permeability. The capacities as determined from such tests will probably be high, because steady-state conditions have not been established. Open-flow tests and tests at high rates may be dangerous from the standpoint of their effects on the subsurface behaviour of the well. The back-pressure method has its own disadvantages, the chief one being the number of accurate points required to obtain correct conclusions. In addition to build-up of reservoir pressure, it is possible to obtain an index of the well capacity from building-up-pressure data. This method requires that bottom-hole or fluid-level data be obtained in oil wells. In gas wells the bottom-hole pressure, or its value as calculated from top-hole pressure, is necessary. The advantage of this method is that information applicable to general reservoir problems can be obtained at one time and over a short period. The method requires that the well be produced at or near some uniform rate for sufficient time to reach steady conditions. The length of time required for this condition to be met may vary from a fraction of an hour for wells of high productive rates to several days for wells of low permeability. The build-up pressure should be taken over a considerable period, but need not be so long as the time to reach steady-stage conditions. The only disadvantage of the method is that it requires that the well be shut-in for a time.

The paper gives a method calculating the reservoir pressure and well capacity from build-up data, using the author's method of successive approximation.

A. H. N.

467.* Factors Affecting Changes in Crude Oil Gravities. R. Reaves. *Oil Wkly*, 4.1.43, **108** (5), 39–40.—In broad analysis the gravities of oil in stock-tanks are affected by the following factors: (1) The composition of the oil–gas mixture as it leaves the reservoir. (2) The pressure at which gas–oil separation occurs on the lease. (3) The separating temperature. (4) The number of stages of gas–oil separations through

which fluid passes before going to the stock-tank. (5) The effect of the water produced. (6) The effect of gas lift. (7) The method and practices used in treating emulsions. (8) The impurities and content of the treated oil. (9) The accuracy of making determinations. The gravity of oil produced from a specific reservoir—that is to say, a sand of average thickness in any particular field, ordinarily varies a very small amount, provided the oil is either saturated or under-saturated with gas.

The chief factors of those enumerated are briefly discussed. A. H. N.

468. Job Design As Applied To The Pumper's Daily Routine. H. G. Thuesen and M. R. Lohmann. *Oil Gas J.*, 7.1.43, **41** (35), 115–118.—Job design consists of determining the essentials and selecting the effective elements for the accomplishment of the essentials. Improvements in the effectiveness of labour utilization are obtained by: (1) Eliminating unnecessary work elements. (2) Substituting effective for ineffective elements. (3) Eliminating periods of enforced idleness. By testing each element of work of the job against the criterion of whether it assists in the accomplishment of the work objective, the effective work elements are chosen. These work elements are then arranged in the proper sequence for smooth and uninterrupted performance. Opinions of workmen and supervisors are essential in analyzing the elements of a job, but as it is impossible to measure and test these elements by casual observation, it is necessary to make a detailed time study of the job. A stop watch, more commonly known as a decimal timer, is used, with which the duration of the elements of the job can be measured with considerable precision. In some instances a motion-picture camera is of considerable assistance in recording and measuring rapid action in jobs of short duration. Sufficient observations, including a detailed record of the elements of the work performed and the time of each element, must be made of the job in the field. The length of these observations may vary from hours to days, depending on the repetitiveness of the job, but sufficient studies should be made so that the observation is representative of the job. Jobs must be designed by the co-operative efforts of the supervisor, who defines the objectives, and an experienced job designer, who measures the job and designs it around the objectives.

For analysis, the objectives for which the pumper is employed may be classified as follows: (1) Detect trouble which would result in damage or loss of production and correct or report same to lease foreman. (2) Service, adjust, and make minor repairs to equipment on the lease. (3) Switch, top-out and gauge-tanks, report gauges and run oil to the pipe-line. (4) Maintain the lease and lease equipment to the desired standard of cleanliness and orderliness. The first three classifications embrace a large percentage of the pumper's activities, and most of these are performed during regular visits to the wells. The paper gives a method of estimating the economical number of visits to the wells to minimize production loss. A. H. N.

469. Kansas Drawdown Productivity Tests Cut Well Costs and Equipment Needs. N. Williams. *Oil Gas J.*, 7.1.43, **41** (35), 119.—With the draw-down method the productivity of a well is computed from measurements of the effects of production on the height of the fluid column in the well. Production at low rates serves as well as, if not better than, production at high rates in this calculation. In gas-free or pumping wells, characteristic of Kansas, the fluid column standing in the well is the only force within the well retarding movement of oil into the well-bore; hence, reduction in height of the fluid column is a function of rate of production and directly proportional to it, if the resulting values of equilibrium fluid height are plotted against their corresponding rates of production, a "draw-down" curve is obtained, which, extrapolated to zero fluid height, yields the theoretical maximum rate of production. The footage difference in height of the fluid column under static conditions and the height at a given rate of production is the draw-down for that rate of production. The slope of the draw-down curve determines the productivity index of the well, which may be considered as gross production/ft. of fluid draw-down.

Productivity as determined by this method is the indicated performance of a well at high rates, rather than a gauge of the actual volume of oil a well can produce. This accounts for some of the unreasonably high "potential" figures often attributed to Kansas pumping wells. However, although the indicated productivity of a well may appear excessive, it serves as a reliable basis for determining the relative importance or rating of wells for the purpose of production allocation.

As the tests require small rates of production only, the cost of the pumping unit and other equipment—necessarily smaller than those required by other tests using high rates of flow—becomes low, resulting in cutting the well costs.

The procedure prescribed by the Conservation Division for making the tests is as follows: "Three liquid-level points shall be established, in each case after the well has reached equilibrium. . . . Pumping speeds or flowing rates shall be sufficient to establish definite points for the extrapolation of the draw-down curve. The high rate shall be at least 15 brl. of liquid/hour. The low rate shall be at least 10 brl. of liquid/hour less than the high rate, and the intermediate rate shall be at least 4 brl./hour more than the low rate. Production gauges for each fluid-level determination shall be taken for at least 3 hours for each production rate point after equilibrium has been reached. The draw-down curve shall be a straight line plotted through the lowest production rate point and at a point which is the average of the two higher points established by the test. . . . The straight line shall be extrapolated to indicate the productivity of the well if pumped down to the top of the producing horizon, provided such indicated productivity is less than the maximum permissible productivity herein before prescribed. If such indicated productivity is greater than the prescribed maximum, the value shall not be extrapolated beyond such maximum."

A. H. N.

470. Job Design As Applied to the Pumper's Daily Routine. Part 2. H. G. Thuesen and M. R. Lohmann. *Oil Gas J.*, 14.1.43, **41** (36), 36.—In the second part of the paper the principles outlined in the first part are applied in a typical case and the problems met are solved in detail. A schedule is then outlined for the pumper. In this case example the average number of wells handled by one pumper was nine. After job design the same pumper could handle twenty wells, or an increase of 122%. On a per-well basis, annual pumping labour costs will drop from $700 to $315, or 55%. The schedules as worked out in this paper are applicable to the over 100 wells controlled by the operator in the field, making total labour savings in excess of $40,000. In addition, job design allows an equal distribution of work on the basis of the time and effort expended by the pumper. Savings of this proportion are not unusual, as similar applications of job designs in fields in other areas have shown percentage savings comparable to this case example. Where production/well is small, as is the case in many fields, similar percentage increases in the number of wells handled by one pumper, even though the pumper may now be handling more wells than in this case example, are possible by the application of study and design. Job design is not limited to pumpers or pumping, as successful applications have been made to well servicing, maintenance, and other production jobs. A. H. N.

471. Stripper-Well Surface Equipment. N. Williams. *Oil Gas J.*, 14.1.43, **41** (36), 46.—Subsurface equipment are important factors in determining the efficiency of pumping wells. Another factor to be considered in pumping efficiency, especially as it relates to stripper wells, has to do with surface pumping equipment and methods. Subsurface equipment can be in perfect condition, properly set and adjusted, and of adequate capacity, but if the surface equipment is not of suitable type or size, or is not properly operated, the maximum efficiency of the subsurface equipment cannot be realized, and the greatest possible volume of fluid the well is potentially capable of producing cannot be lifted. Speed and length of strokes are functions solely of the surface equipment. Hence, any increases in well output that is to be obtained by faster and longer strokes is entirely dependent on mechanical adjustments at the surface.

In many cases the surface pumping equipment on stripper wells is incapable of lifting more fluid. Much of it, by reason of the age of the wells and original installations not having been replaced, is old. Frequently it consists of assortments of more or less obsolete types of rig-fronts, makeshift central power hook-ups, or improvised units and jacks in multiple operation. Sometimes it is patched together with junk. Old assemblies and practices often do not permit flexibility in pumping individual wells to obtain the most effective results. Along with this, operating and maintenance costs of this type of equipment may be so uneconomical that profitable production of wells is difficult. Tests for determining the advisability of changing equipment are very briefly mentioned. A. H. N.

472.* Gravitational Drainage of Liquids from Unconsolidated Wilcox Sand. F. R. Stahl, W. A. Martin and R. L. Huntingdon. *Petrol. Tech.*, January 1943, **6** (1), A.I.M.M.E. Tech. Pub. No. 1548, 1–8.—Vertical tubes of 2-in. and 4-in. iron pipe were equipped with water-jackets, and nipples at various levels for taking sand samples, while a drainage cock was fitted at the bottom. The tubes were filled with well-packed outcrop Wilcox sand, the porosity of which was approximately 32%. The permeability, measured with dry natural gas, averaged 7·5 darcys. The sand-filled tubes were filled with liquid forced in through the bottom, liquid being allowed to flow out of the top. Drainage from the base was permitted for a time, after which the tube was refilled ready for the drainage observations. In the experiments the bottom cock was opened and the amount of liquid collected was noted from time to time. Cores were taken by a cork-borer inserted through the nipples, the amount of oil in the cores being found by firing. The density, viscosity, and surface tension of each liquid (water, Wilcox crude, and heptane) were measured. The core samples were taken in the transient experiments to find the saturations at different levels at times before drainage was complete.

A slightly higher recovery was obtained with both Wilcox crude and with water at high temperatures than at low temperatures. In the intermittent drainage experiment flow of liquid from the bottom of the tube was stopped before drainage was complete, and the liquid distribution was determined immediately, and again after standing for some time. While shut in the upper part of the tube drained almost to equilibrium and the rest was enriched. On reopening the tube the initial rate of flow was greater than just before it was shut in.

Curves show the final vertical saturation distributions of the three liquids, the transient saturation distribution for Wilcox crude, cumulative drainage curves for Wilcox crude at different temperatures, drainage rates for water at different temperatures, and the data obtained in the intermittent flow experiment. G. D. H.

473. Patents on Production. A. J. Collins. U.S.P. 2,305,139, 15.12.42. Appl. 9.2.40. Firing means for well-perforating guns.

R. D. Alexander. U.S.P. 2,305,229, 15.12.42. Appl. 8.12.41. Signal apparatus in a well-tubing consisting of an electrode protruding outside the tubing.

H. U. Garrett and C. V. Temple. U.S.P. 2,305,250, 15.12.42. Appl. 23.2.39. Flow-valve in the side of well-tubing.

R. G. Taylor, Jr., and D. B. Hooser. U.S.P. 2,305,282, 15.12.42. Appl. 22.3.41. Swab-cup construction and method of making same.

R. B. Price and O. K. Hobbs. U.S.P. 2,305,388, 15.12.42. Appl. 9.5.41. Rodless bottom-hole pump with reciprocating cylinder and piston.

J. B. Van Horn. U.S.P. 2,305,648, 22.12.42. Appl. 15.12.41. Submersible motor structure having a dielectric in a motor housing and motor.

M. De Groote, B. Keiser, and C. M. Blair, Jr. U.S.P. 2,306,329, 22.12.42. Appl. 27.6.40. Process for breaking petroleum emulsions.

H. J. Pankratz. U.S.P. 2,306,558, 29.12.42. Appl. 6.5.41. Pump drive-head for use with a deep-well pump.

H. R. Pendleton. U.S.P. 2,306,560, 29.12.42. Appl. 21.6.42. Sand extractor for oil-well pumps.

W. N. Sutliff. U.S.P. 2,306,670, 29.12.42. Appl. 19.8.39. Well-casing perforating device comprising a motor driving a drilling bit at right angles to its own axis.

M. De Groote and B. Keiser. U.S.P. 2,306,718, 29.12.42. Appl. 27.6.40. Process for breaking petroleum emulsions.

C. M. Blair, Jr. U.S.P. 2,306,775, 29.12.42. Appl. 17.8.40. Process for breaking petroleum emulsions.

L. D. Mowrey. U.S.P. 2,306,828, 29.12.42. Appl. 23.10.40. Well flowing device, by gas lift.

K. Fischer. U.S.P. 2,306,940, 29.12.42. Appl. 22.10.41. Flow-meter using an orifice and turbulence creating means to make flow substantially independent of viscosity.

A. Boynton. U.S.P. 2,307,016, 5.1.43. Appl. 8.12.39. Differential stage lift-flow device, diaphragm type.

A. Moeller. U.S.P. 2,307,058, 5.1.43. Appl. 7.6.38. Breaking agent for emulsions from crude petroleum.

F. S. Tutton. U.S.P. 2,307,171, 5.1.43. Appl. 15.12.39. System and apparatus for flowing wells by means of flowing valves in the side of tubings.

A. J. Collins. U.S.P. 2,307,360, 5.1.43. Appl. 9.12.40. Well-perforating gun with firing by hydraulic pressure.

C. J. Coberly. U.S.P. 2,307,451, 5.1.43. Appl. 2.8.40. Hydraulic pump with mechanically actuated intake valve.

L. G. Davenport. U.S.P. 2,307,492, 5.1.43. Appl. 30.10.39. Adjustable beam-saddle for pumping beams.

M. De Groote and B. Keiser. U.S.P. 2,307,494, 5.1.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,307,494, 5.1.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

H. D. Woodmansee. U.S.P. 2,307,557, 5.1.43. Appl. 7.5.40. Apparatus for elevating fluids in wells.

A. S. Baylor. U.S.P. 2,307,662, 5.1.43. Appl. 22.7.39. Means for controlling wells by sealing its upper end.

A. D. Larson. U.S.P. 2,307,688, 5.1.43. Appl. 8.8.41. Combination sucker-rod guide and paraffin scraper.

J. L. Foster. U.S.P. 2,307,729, 5.1.43. Appl. 17.3.39. Well explosive in a projectile which is fired into the formation, wherein it explodes.

J. B. Picard. U.S.P. 2,307,952, 12.1.43. Appl. 15.6.40. Pumping jack in the form of a walking-beam structure.

C. H. Barnes. U.S.P. 2,307,983, 12.1.43. Appl. 22.1.40. Selective production means for wells, to be interposed in a tubing-string.

M. P. Burke. U.S.P. 2,307,991, 12.1.43. Appl. 21.4.38. Fluid lift-valve at bottom of tubings.

M. L. Hart. U.S.P. 2,308,004, 12.1.43. Appl. 10.1.41. Setting tool for bridging plugs for wells.

R. E. Hendrickson. U.S.P. 2,308,006, 12.1.43. Appl. 4.8.41. Perforation burr element in connection with a gun perforator used to reduce burr formation.

J. S. Crump. U.S.P. 2,308,156, 12.1.43. Appl. 29.8.40. Bore-hole sampler carried by a wire.

J. E. Eckel and G. M. McCarty. U.S.P. 2,308,160, 12.1.43. Appl. 16.3.40. Sand-filter for oil and gas wells.

E. L. Potts. U.S.P. 2,308,387, 12.1.43. Appl. 21.11.41. Tester to be used in oil wells.

O. F. Ritzmann. U.S.P. 2,308,390, 12.1.43. Appl. 9.12.40. Apparatus for detecting and exhibiting explosions in wells.

W. B. Campbell. U.S.P. 2,308,414, 12.1.43. Appl. 26.4.41. Treatment of wells prior to acidizing the formations.

C. A. Prince. U.S.P. 2,308,425, 12.1.43. Appl. 6.4.38. Treatment of wells to form an adherent cement lining on a section of a well-bore penetrating an acid-soluble formation.

A. B. Scott. U.S.P. 2,308,633, 19.1.43. Appl. 9.9.40. Sand-bailer and perforator cleaner.

O. E. Barstow. U.S.P. 2,308,668, 19.1.43. Appl. 28.8.40. Apparatus for treating wells by which two or more formations are treated simultaneously by fluids.

S. A. Brown and A. P. Ruth. U.S.P. 2,308,742, 19.1.43. Appl. 25.4.41. Pump in a tubular pump-casing.

M. De Groote and B. Keiser. U.S.P. 2,309,243, 26.1.43. Appl. 25.5.42. Process for breaking petroleum emulsions.

W. J. Crites. U.S.P. 2,309,383, 16.1.43. Appl. 8.3.41. Deep-well pump.

R. L. Kirkpatrick. U.S.P. 2,309,512, 26.1.43. Appl. 21.3.41. Gas-lift oil-recovery system.

C. J. Coberly. U.S.P. 2,310,397, 9.2.43. Appl. 24.1.38. Method of packing wells and removing sand grains from the production lines of wells.

C. E. Bodey, Jr. U.S.P. 2,310,507, 9.2.43. Appl. 22.11.40. Deep-well screen using helical wire and spreader members.

E. Burns. U.S.P. 2,310,572, 9.2.43. Appl. 26.9.41. By-pass-type liner hanger.

E. M. Wagner. U.S.P. 2,310,757, 9.2.43. Appl. 12.5.41. Means of preventing pitting of well-pumps. A. H. N.

Transport and Storage.

474.* Turbochargers Increase Output of Four-Cycle Diesel Engines. J. P. Stewart. *Oil Gas J.*, 24.9.42, **41** (20), 113.—With the object of utilizing all pipe-line facilities to the fullest extent, special attention is being given to obtaining more power reliably from existing pump-station diesel equipment.

As far as is known, superchargers installed at pumping stations are all designed according to the Buchi system, and the combined output of engines utilizing this method exceeds 2 million b.h.p. The system has been applied to numerous types and sizes of engines of conventional design, with substantial increases in output, generally of the order of 35–40%. Applications have been made successfully to both air and solid injection engines, as well as low, medium, and high-speed engines. In general the open-type combustion chamber with central injection has given the best results. A description is given of the turbocharger unit, and of its method of operation. Advantages to be obtained by the application of Elliott–Buchi turbochargers to existing engines are enumerated. In considering the application of a turbocharger to an engine, it must first be established whether the power increase can be utilized effectively by the driven machine. Since certain new engine parts are required when the turbocharger is installed, customary practice is to have such application sponsored by the original engine manufacturer. R. A. E.

475.* Study of Corrosion Aids in Protection of Pipe Lines. Anon. *Oil Gas J.*, 24.9.42, **41** (20), 191.—Selected portions of a review entitled "Corrosion in Soils" issued by the Bureau of Standards are presented. This review is a summary and restatement of observations related to underground corrosion that have been presented in publications of the Bureau of Standards and in technical journals, and is intended for the information of a non-technical enquirer who has a specific corrosion problem for which he requires a practical solution.

References to the more important books and articles dealing with corrosion are given. R. A. E.

476.* Chart Facilitates Determination of Tank Capacities. Anon. *Oil Gas J.*, 10.12.42, **41** (31), 44.—Charts and tables are presented to enable rapid determination of the approximate capacities of vertical tanks from a knowledge of the internal diameter, or internal circumference, and the height. The charts have been prepared by L. T. Monson of the Tretolite Co. of California and large reproductions of the scales are obtainable from the author and company. The scales cover a range of 8 ft. to 170 ft. internal diameter and 0·6 ft. to 65 ft. in height, and are divided into two sections, viz. below and above 55 ft. internal diameter. R. A. E.

Gas.

477. Compression Gasoline Recovery Combined with Pressure Maintenance. Anon. *Refiner*, December 1942, **21** (12), 473–474.—In order to take advantage of pressure maintenance in the reservoir of the Maljanar field, Lea County, New Mexico, compression recovery of natural gasoline was adopted for the co-operative project, which was completed in April 1942. Extraction is accomplished in four stages of compression from vacuum to 1600 lb., the requirement for the oil-producing sand. The plant is briefly described. A. H. N.

478. Methane Utilization in Italy. Anon. *Chem. Tr. J.*, 19.3.43, **112**, 271.—It has been stated that a large methane pipe-line is being erected in the Department of Emilia in Italy as a joint undertaking by the State Methane Co., the Azienda Generale Italiana Petrole and other companies. It will be about 168 miles long, and will carry 40,000 c. metres of methane daily at 200 atmos. pressure, half to Milan and about a seventh each for Reggio, Lodi, and Palma. The section from Milan to Piacenza has been placed in operation. C. L. G.

479. Butylene in Fruit Growing. Anon. *Chem. Tr. J.*, 9.4.43, **112**, 2916.—In the U.S.S.R., butylene is used to stimulate the growth and ripening of fruit trees such as apples, apricots, pears, plums, peaches, and walnuts, for which the growing season in many parts of the U.S.S.R. is too short to allow of full maturing. The tree is enclosed in a tent for two weeks before the growth-cycle starts, and butylene is passed into the tent in concentrations of 1 part in 100,000 of air, at a temperature of 69–100° F. for 1–2 hours. C. L. G.

Refining and Refinery Plant.

480. Boiler Plant Operation and Care. R. W. Machen. *Refiner*, December 1942, **21** (12), 451–454.—The problems of operating and maintaining boilers are discussed, the following recommendations being the main final conclusions: (1) Inspect the water level in the boiler frequently, not only by the visual means provided by the water-gauge glass, but also by using the try-cocks. The use of the try-cock will often show that the gauge-glass is not working properly. (2) Low-level instructions should be carefully followed. Water should never be pumped into a boiler that has a low water level, and it is advisable to cut the fire under that boiler until it has cooled sufficiently to permit the raising of the water level to its proper position. Continued firing and pumping of water into a boiler having a low water level may cause destruction of the boiler along with damaging effects to other parts of the equipment, and even loss of life. (3) Pressure-gauges and safety-valves should be inspected regularly and kept in shape to meet any possible emergency. (4) Boilers should be blown down properly and as a matter of routine. The number of times each tour that the boiler must be blown down is dependent on the concentration of chlorides in the boiler, and on the general overall condition of the feed-water. The percentage of blow-down will vary with the conditions under which the boiler is being operated. (5) Preparation and inspection of the boiler should always be made before it is fired up, to assure that the water level, draft, gas-free combustion box, and valve positions on incoming and outgoing lines are all in their respective correct positions and condition. It is important that the firemen know how to turn the boiler into the steam-header. The most common abuses are the ignoring of the safety precautions concerning the clearance of the combustion chamber of any accumulated gases, firing up with too high or too low water level, firing the boiler too rapidly, and cutting the boiler into the battery header before the boiler pressure is as high as the header pressure. (6) The correct routine for bringing a boiler out of normal service should include the sealing-off of steam, blow-down, and feed-water valves. Disconnection of fuel-lines from the burners and slow cooling of the boiler by leaving the fire-box and smoke-box doors closed should be emphasized. (7) Elimination of oil from the feed-water should be a prime requisite, and the scale accumulation should be kept at a minimum by proper treatment. The best policy is to start proper care of the boiler when it is unloaded and loaded for movement. Starting out with a new boiler

means starting out with a clean boiler. Keeping it clean by blowing down frequently and washing periodically and regularly will increase its useful life.

The position of the burner has also a great effect and must be carefully studied.

A. H. N.

481. Installation and Servicing of Pumps and Compressors in Refining Service. J. F. Rollins. *Refiner*, December 1942, **21** (12), 455–462.—Detailed instructions are given for the correct procedure and precautions to be taken in installing compressors. Lubrication is discussed separately and at length, and maintenance is also discussed.

If there is excessive condensate in the gas being handled by the compressor, a knock may develop which might appear to be in the running gear of the machine. If the discharge is on the bottom side of the cylinder, the knock will be less pronounced than when the suction is on the bottom. When these conditions are encountered, several different measures may be taken to overcome the difficulty. If possible a condensate-removal pot should be installed on the suction line just before the machine; a leg with a drain may be provided for at the point where the gas enters the cylinder; a drain can be installed on the cylinder so that the condensate can be drained from the suction-valve pocket, or the cooling water to the compressor jacket may be heated so as to maintain the temperature of the metal above the dew-point of the gas. If this is done, care must be taken to ensure that the water is uniform in temperature, so as not to set up excessive stresses in the water-jacket metal. This may occur if the water is heated by the direct injection of steam. Where this method is used, the injection point should be sufficiently removed from the cylinder, and the line should be large, so that an even temperature is maintained. The injection of steam may cause the formation of scale in the lines or water-jackets. A heat exchanger is preferable to the direct injection of steam, as a more uniform temperature is assured. The heat exchanger method also eliminates the possibility of deposit, and will be found to be much more satisfactory.

The safety devices used on compressors have undergone extensive improvement, so that at the present time a very satisfactory control or alarm can be obtained for practically any purpose. This has eliminated the possibility of a hazardous condition developing from the leakage of inflammable gases in the vicinity of a machine. However, even though these accessories may be explosion proof, certain safety practices must be observed in order to ensure that an accident will not occur. If, after a thorough knowledge of the conditions, it has been deemed necessary to install explosion-proof equipment, all accessories should be of that type. If one device of several is not of the safety design, the advantage of the others is greatly diminished, and may eventually prove to be a definite hazard. Such a condition may cause the operating personnel to become careless, which is a situation the management of every plant wishes to avoid.

A. H. N.

482. Maintenance Shop Prolongs Meter Usefulness. Anon. *Refiner*, December 1942, **21** (12), 463–466.—A description is given of a particular maintenance and repair shop. When any meter, regardless of time in service, shows that either the static or differential will not zero correctly, or that any other function is out of calibration, it is removed from the station and a reconditioned instrument installed in its place. All fittings, except the orifice flange, are removed from the setting. The levelling flange and support go with the instrument, so all parts can be inspected when it arrives at the shop. The shop operates on a production-line system, with the receiving dock at one side and the meter store-room at the other. Meters are broken down at the dock. All parts, after preliminary inspection, are placed in a wire basket and lowered into a vat of boiling chemicals to remove paint and field grime. Then a water-bath removes both chemicals and grime. After dyeing, each part is brushed to remove powdered residue, rust, and discoloration.

The batch of parts is sorted, with pen lifters, pen parts, " U " bends and check valves, floats, and pressure-tight bearings all laid out separately for inspection. The mercury pot is brushed on the inside, and any lumps chipped or ground down so that the interior surface is free of protuberances which might hinder the float from rising and falling with full freedom. The assembled by-pass piping and needle valves are cleaned on the inside by blowing with compressed air, after which this portion of the piping is tested for leaks. If none are apparent, the assembly is not broken down, but when pinholes or defective threads are indicated, new nipples are sub-

stituted. After the parts are brushed they are further inspected and repaired, painted or lacquered and assembled, so that it is difficult to distinguish between the new and the repaired meter. To ensure long service and correct recording of the flow of gas through the orifice fitting, repairs are limited to the meter-shop. Nothing of importance is done in the field towards adding or withdrawing mercury from the float chambers, and the only attention an instrument receives while in service is the care given it by the chart man, who only takes off and replaces charts and winds the clock. Protection is afforded the instrument at the meter station by a sheet-iron shield, which prevents the entry of rain when the chart door is opened. This shield is attached to the case by stove-bolts, employing the mounting holes in the flange of the case which may be used if the instrument is set on a board inside a building.

A. H. N.

483. Mechanical Performance of Hot-Oil Centrifugal Pumps. A. J. Stepanoff. *Refiner*, December 1942, **21** (12), 467–472.—The development of the modern hot-oil pumps depended on a satisfactory solution of the following problems: (1) Stuffing box; (2) high speed for high heads; (3) coking of pump passages; (4) design of casing to stand high pressures, temperatures, and corrosion; (5) heat expansion with seizure and scoring of internal parts; (6) uneven heat absorption and radiation by pump casings. Each item is discussed separately. In connection with the stuffing boxes, experience has taught that a good metallic packing, rustless hard sleeves, and freedom from vibration are the prerequisites for successful stuffing-box operation. The number of rings should not be too great, as even with hot oils a satisfactory studding-box operation depends on a slight leakage for lubrication. To prevent hot oil spraying by the shaft-sleeve, a water-quench on the gland is used. Water-jacketing of stuffing-boxes is universal on hot-oil pumps. The application of centrifugal pumps to pumping of light hydrocarbons in recent years presented somewhat different stuffing-box problems, but with experience accumulated on hot oils, these were satisfactorily solved in a comparatively short time. In this case the liquid is cold, while the stuffing-box pressures are high, and the liquid flashes into gas at atmospheric pressure; thus it is impossible to lubricate stuffing-boxes with the pumped liquid. In most cases sealing of the stuffing-boxes with a heavier oil at a pressure slightly above the vapour pressure of the pumped liquid is resorted to. In many cases heating of the stuffing-boxes through the jackets has been found helpful to counterbalance the refrigerating effect of the escaping expanding gas.

One of the more interesting problems discussed in connection with thermally caused troubles is that of a heated member being confined in space by an uninsulated casing. The diaphragm separating the suction-chamber from the discharge casing is closely fitted into the casing. A pump of this type when pumping oils at temperatures of about 800° F., when the casing is not insulated and exposed to outside temperature, will have the diaphragm at the temperature of the hot oil, while the casing is several hundred degrees lower. The expansion of the diaphragm being restricted by the cooler casing may result in a compression of the diaphragm and tension in the casing beyond the elastic limit, and both will receive a permanent deformation. When cold, the diaphragm will be loose in the casing. If the joint between the volute casing and suction chamber is made without a gasket (depending on metal-to-metal fit), loss of capacity will result when the pump is operated at a temperature lower than the maximum to which the casing was subjected. The magnitude of stresses developed under such conditions can be judged by the fact that steel casings were found cracked under such conditions with perfectly sound steel castings of normal wall thickness. Calculations show that if a steel bar is heated and its expansion is prevented by an outside force it takes 100° F. for the bar to reach its elastic limit of 50,000 lb./sq. in. If heating is continued, the bar will get a permanent deformation and will be crushed. On cooling, the bar will contract in a regular manner, and will be shorter than the original length. This is independent of bar section or length. A. H. N.

Chemistry and Physics of Petroleum.

484.* The Oxidation of Aliphatic Hydrocarbons. G. Egloff, D. V. Nordman, and P. M. Arsdell. *Oil Gas J.*, Part I, 24.9.42, **41** (20), 207; Part II, 1.10.42, **41** (21), 35; Part III, 8.10.42, **41** (22), 49.—The oxidation of hydrocarbons plays an important rôle in the oil industry, *e.g.* in corrosion, formation of gum in gasoline, deterioration

of lubricants, combustion of fuels for heating and operation of engines, and production of oxidized derivatives.

The articles deal with the oxidation of the aliphatic hydrocarbons only. Theories of mechanism of reactions which have been propounded are presented and discussed. References to the literature are provided, and results obtained by investigations are briefly summarized under appropriate headings. Oxidation reactions of aliphatic hydrocarbons are characterized by induction periods and are sensitized by the addition of intermediate oxidation products. Alkane oxidation occurs at temperatures lower than are necessary for alkene–oxygen reactions.

Hydrocarbon–oxygen reaction rates are increased by increase of pressure, alkanes being more affected by pressure change than alkenes. Normal alkanes are more readily oxidized than branched isomers, and lengthening the normal chain facilitates oxidation.

Part I deals mainly with the thermal oxidation of alkanes. Effects of temperature, pressure, composition of reacting mixture, addition of substances which accelerate or inhibit the rate of reaction are discussed. A table shows reaction conditions and reaction products obtained from the lower members of the series. Oxidation of the higher-molecular-weight aliphatic petroleum fractions and solid waxes has been of considerable importance from an industrial aspect, *e.g.*, the manufacture of lubricant additives, soaps for use in textile industries, emulsion breaking agents, foam preventers, etc.

Part II. Alkane oxidation may be catalyzed by nitrogen oxides, metals, and metallic oxides. The use of oxidants other than oxygen, *e.g.*, metallic oxides, ozone, perchloric acid, etc., is also discussed. A table shows the types of reactions mentioned in these two sections, indicating the hydrocarbon treated, temperature of reaction, catalyst used, and reaction products obtained. From mixtures of hydrocarbon gases in the form of refinery and natural gases, *iso*propyl alcohol, acetone, ethyl alcohol, acetic anhydride, methylethylketone and ethylene glycol have been produced on the commercial scale.

Products obtained by thermal oxidation of alkenes up to C_8 are detailed, with information on the effects of temperature, pressure and other conditions of operation, the use of inert gases as diluents and effects of addition of oxygenated products.

Part III deals mainly with the effects of various catalysts on the thermal oxidation of alkenes, with the use of oxidation agents other than oxygen gas, *e.g.*, ozone, hydrogen peroxide, selenium dioxide, permanganate, etc., and with the oxidation of alkynes. Suitable tables summarize the principal data available on these subjects under the headings of hydrocarbon, oxidation agent, catalyst used (if any), temperature and pressure of reaction and reaction products formed. R. A. E.

485. Chemical Utilization of Natural Gas and Natural Gasoline Hydrocarbons by Oxidation. H. Linford. *Refiner*, December 1942, **21** (12), 439–446.—According to figures presented by the Bureau of Mines, the estimated production of natural gas in the United States in 1939 was 3,333,500,000,000 cu. ft. Of this amount 2,476,756,000,000 cu. ft., or about 74% was marketed; 856,744,000,000 cu. ft., or 26%, presumably being used in the oil-fields for pressuring wells or wasted. Roughly, 15% of the marketed gas was used in the production of carbon black and 85% used as fuel. The average value for natural gas in the United States in 1939 was 4·9 cents/1000 cu. ft. Some interesting calculations have been made to show the weight of natural gas produced in the United States. By making broad assumptions as to its average composition it is estimated that in 1939 about 100,000,000 tons of natural gas was produced. Assuming that all of the gas was treated for the recovery of natural gasoline there should have been produced about 9,000,000 tons of natural gasoline, including butane and propane, leaving approximately 91,000,000 tons of the dry gas. This is obviously a rich raw material source and justifies investigation of its possible chemical utilization. The paper discusses the possibilities of each of the lower members of the paraffin homologues and of natural gas.

The apparent slowness of the oil industry to enter the chemical field is attributed to the facts that (1) the industry has been so engrossed in producing huge quantities of crude oil and refining this material at a profit that consideration of chemical outlets, which at best would utilize relatively small amounts of petroleum, has not seemed desirable; (2) the costs of plants required for chemical production are, in

general, far greater than the usual refinery construction costs; (3) the rapidly changing character of the chemical market makes it imperative that a manufacturer be ready to convert his plants and processes to meet the changing conditions. Thus, chemicals that to-day are novelties and of little commercial value, may to-morrow be required in large quantities, and others, which to-day are being used in large amounts, may be displaced to-morrow by better or cheaper substitutes. A. H. N.

486. Pilot-Plant Study of the Gray Clay-Treating Process. A. W. Cobb and L. Carlson. *Refiner*, December 1942, **21** (12), 447–450.—Early investigations are described and the reasons for building the pilot plant discussed. An experimental pilot plant was installed close to the large plant cracking equipment, taking vapours from the vapour line leading to one of the plant Gray units. In this way an entirely representative portion of the cracked gasoline and fixed gases was available for the experimental unit. It was also possible to compare directly the plant-scale-treating operation with the results on the experimental unit.

The experimental unit consisted of two complete clay-treating systems, each having its own after-fractionator, condenser, and receiver; the two systems were so arranged that they could be operated in series, in parallel, or singly. An important advantage of the double system and parallel operation provision resided in the fact that when investigating such variables as catalyst, time of contact, etc., it was always possible to compare the effect of the experimental conditions simultaneously and directly with the effect of standard operating conditions and on precisely the same feed-stock. Accurate determination of the effects of individual variables with a single experimental unit is not feasible, due to the normal variation in the commercially-produced feed to the experimental unit from day to day and from run to run. (The simultaneous operation of a control as described is somewhat analogous to running a blank in analytical chemistry.) A flow diagram illustrates the plant, and its operation is fully discussed. The results of the pilot plant are correlated with results of large-scale plant and compared with laboratory glass clay-treating apparatus.

In contrast to the direct correlation between pilot-plant and large-scale treating is the performance of a laboratory-glass clay-treating apparatus used for some earlier investigations. This apparatus operated at atmospheric pressure and about 300° F. with the rate of throughput in brl./ton/hour of treated gasoline being about double normal plant rates, but with the vapour velocity lower than normal plant velocities due to the shortness of the clay bed. In this case the copper-dish gum of the treated product was at all clay lives considerably higher than plant gasoline, and the colour of the treated product began to drop from 30 Saybolt at about 200 brl./ton clay life and reached about 23 Saybolt at 600 brl./ton.

Experimental results are studied in some detail. A. H. N.

487. Frictional Phenomena. VI. A. Gemant. *J. Appl. Phys.*, January 1942, **13** (1), 22–29.—In this part of the series of papers by the author the methods of measuring viscosity are reviewed. Capillary viscometry of Newtonian substances is discussed, and with it a new type of capillary viscometer, the oscillation viscometer. Instead of employing a stationary flow, it operates on the basis of maintained oscillations of the liquid in a tube of circular cross section. Thus it is not time, but simply the amplitude of the oscillation that is measured. Although the actual displacement varies periodically with time, the amplitude is constant, and can be made to be read directly. The amplitude in such a system is given by the pressure amplitude divided by the resistance of the liquid column. Generally, there are three elements of resistance—namely, gravitation, inertia, and viscous forces. In the apparatus designed by Southwell and the author, the resistance is mainly due to viscosity. The working of the apparatus and the formula used for calculation are given. The viscometer is direct reading.

Couette and falling sphere viscometers are then discussed with references to the literature on the different modifications made. Finally the principles of determining the viscosity of liquids by measuring the propagation and absorption of supersomics are discussed. A. H. N.

488. On the Resistance to the Uniform Motion of a Solid Through a Viscous Liquid. II. R. B. Block. *J. Appl. Phys.*, January 1942, **13** (1), 56–65.—This paper constitutes the answer to some adverse criticisms (*ibid.*, 1941, **12**, 257–258) of an earlier paper

having the same title and reporting evidence for the assumption of liquid slip at the surface of a solid motion through a viscous liquid (*ibid.*, 1940, **11**, 635–642). The importance of the results contained in the earlier paper to viscometry by the rolling-ball method is emphasized. This relation exists because the author's apparatus was essentially a rolling-ball viscometer. References are given to independent studies by other investigators which also support the hypothesis of liquid slip. The possibility of the phenomenon being apparent only is brought out by presenting two other interpretations of the author's observations. A new and more accurate method of converting time of roll into viscosity of the liquid than the current graphical one is presented for the rolling-ball viscometer, together with an apparent reason for believing that the calibration curve of this viscometer may not always be independent of pressure. The author's reasons for considering this new source of error in the use of the rolling-ball apparatus for high-pressure viscometry to be actually non-existent are given. Finally, the author discusses an original method for checking the validity of the hypothesis of liquid slip in the case of the rolling-ball viscometer that is entirely different from the method he used in his earlier paper. A. H. N.

Analysis and Testing.

489.* The New Edition of the I.P. Standard Methods for Testing Petroleum and Its Products. J. Cantor, E. P. Driscoll, and A. Osborn. *J. Inst. Petrol.*, January 1943, **29** (229), 21–35.—The new edition of the "I.P. Standard Methods for Testing Petroleum and its Products" is discussed by the authors, new or modified sections or tests being particularly mentioned, and the reasons for the modifications being explained. The paper is followed by a discussion by various members of the Institute. A. H. N.

490.* The Analysis of Trinidad Crude Oils. F. Morton and A. R. Richards. *J. Inst. Petrol.*, February 1943, **29** (230), 55–74.—The method developed in the laboratories of Trinidad Leaseholds, Ltd., for detailed examination of crude oils consists essentially of three separate analyses designated: (*a*) Primary Evaluation, (*b*) Naphtha Characterization, and (*c*) Supplementary Analysis. Each of these items is discussed separately and illustrated diagrammatically where necessary. The normal crude oil evaluation methods have been intended to include detailed analysis of a number of fractions obtained by precise fractionation of the naphtha (F.B.P. 200° C.). The graphical representation of this analysis is shown to be characteristic of the oil, and can be used for the correlation of crude oils, as well as for the detection of minor differences in crude oils produced from the same zone. Details are given of the characteristics of the crude oils from the established producing horizons at the Forest Reserve Field of Trinidad Leaseholds, Ltd. A. H. N.

Special Products.

491. Comparative Toxicity of Kerosines. J. K. Finnegan, E. L. McCawley, O. L. A. Strait. *U.S. Federation Proceedings*, March 1942, **1** (1).—In a study of the effect of type of kerosine vehicle used in fly-sprays, comparative toxicity tests were carried out on a Mid-Continent and a West Coast kerosine by administering to mice a daily oral dose of 5 c.c. per 12 gm. With the Mid-Continent kerosine after six doses, six out of ten mice were killed, and all were dead within two weeks, there being progressive and marked weight loss. With the West Coast kerosine, all were alive after six doses, and six out of ten were alive after four weeks, there being no significant weight changes. Spectroscopic examination of the kerosines revealed chemical differences, but the toxic factor has not yet been isolated. C. L. G.

492. Toxicity and Antiseptic Action of (Petroleum and Coal Tar) Cresylic Acids. J. Campbell. *U.S. Federation Proceedings*, **1** (1).—Comparative tests on petroleum and coal tar cresylic acids indicate that (1) an hour's inhalation of air saturated with cresylic acid (either type) causes local irritation of the eyes and upper respiratory tract, repeated exposure producing several reactions. (2) The petroleum acids are less toxic on oral administration and less irritating to the skin than the coal tar acids,

though both may be absorbed with toxic symptoms. (3) Standard disinfectants from saponified petroleum acids at a concentration of 0·05% are bactericidal at 20 min. application to standard cultures of *S. aureus* and *B. coli* and have no effect on embryonic chick heart, whereas those from coal tar acids at the same time/concentration are not bactericidal and reduce growth and activity of embryonic chick heart.
C. L. G.

493. Gulf Coast Refineries are Abundant Chemical Sources. W. L. Nelson. *Oil Gas J.*, 25.6.42, **41** (7), 165.—The Gulf Coast area is favourably placed for the manufacture of petroleum chemicals, owing to the presence in the crude of relatively high proportions of aromatic hydrocarbons and to the large amounts of natural gas and distillate well fluids available. There is enough butane available to make 400,000 tons of synthetic rubber per annum, or to make the alkylate required for 50,000 brl./day of 100 octane gasoline. Toluene is being manufactured by (*a*) distillation from high aromatic crudes, (*b*) catalytic dehydrogenation and cyclization of *n*-heptane, and (*c*) as a by-product in catalytic cracking processes. While the volume of new chemical products is very small compared to that of normal petroleum products, the cost of production is very much higher, as shown by the following plant costs per brl. daily capacity: complete topping plant \$100–150; complete refinery \$250–400; 100 octane gasoline \$900–1400 and synthetic rubber \$20,000–27,000. Not only are the chemical operations involved more lengthy and complicated than normal plant operations, but a high degree of purity of product is required, necessitating further expensive and troublesome operations. The C_4 hydrocarbons are likely to form the largest source of chemicals, as the lower hydrocarbons must be handled at high pressures, while the higher hydrocarbons are very difficult to separate. In general the lower boiling paraffins, unsaturateds, particularly dienes, and aromatics are likely to be the basis of the petroleum chemical industry. C. L. G.

494. Wide Variety of Chemicals Made from Refinery Gases. W. T. Ziegenhain. *Oil Gas J.*, 25.6.42, **41** (7), 185.—The present trend towards greater correlation of oil production and refinery operations resulting from lower crude oil prices, is likely to lead to greater utilization of refinery by-products for the production of chemicals. A list of typical petroleum chemicals available is given and a tree showing derivatives of pentanes by pyrolysis, oxidation, and chlorination. Details are given of the chlorination process. C. L. G.

495. The Comparative Toxicity of 2-Chloro-2-Butene, 1 : 2 : 3-Trichlorobutane and 1 : 2-Dichloroethane. E. L. McCawley. *Univ. of California Publications in Pharmacology*, 1942, **2** (8), 89.—In view of the better solvent properties for industrial purposes of 2-chloro-2-butene and 1 : 2 : 3-trichlorobutane over 1 : 2-dichloroethane (ethylene dichloride), the toxicity to mice of their vapours and the irritating effect on the skin of rabbits of the liquids have been compared. It is suggested that these materials show the same order of toxicity for human beings as for mice, and that the industrial hazards can be estimated from the following data for the three products: (A) 1 : 2-dichloroethane, (B) 2-chloro-2-butene, and (C) 1 : 2 : 3-trichlorobutane: Concentration detectable by smell (parts per million), (A) 300–1000, (B) 300–1000, (C) 300–1000. Maximum concentration that can be inhaled for 1 hr. without serious disturbance (parts per million): (A) 3000, (B) 10,000, (C) 2500. Dangerous after 30 mins./1 hr. exposure (parts per million): (A) 6100, (B) 48,800, (C) 3000–10,000. Rapidly fatal for exposure less than 15 min. (parts per million): (A) 24,400, (B) 73,200, (C) 10,000. Thus 2-chloro-2-butene is the least dangerous. It is pointed out that 1 : 2 : 3-trichlorobutane has a relatively low volatility, and may therefore be apparently safe, but if the temperature is raised it becomes very dangerous, death occurring without preliminary anæsthesia. This product is also the most irritating, causing considerable erythrema after 1 hr. contact, resulting in inflammation after 24–48 hr. with hematoma and later ulceration. The other two products cause much less irritation and recovery is more rapid. C. L. G.

496.* Styrene for Rubber made from Benzene, Alcohol, or Ethylene. Anon. *Oil Gas J.*, 26.11.42, **41** (29), 34.—The two main processes in commercial use for the production of ethyl benzene for styrene consist of the alkylation of benzene with (*a*)

ethylene or (*b*) ethyl alcohol. In the former process (Dow) ethane is cracked to ethylene which is freed from propylene and contacted with nitration grade benzene (boiling range 1° F.) at about 190° F. and 15 lb. pressure in the presence of anhydrous aluminium chloride catalyst. The crude ethylene used may be as low as 38% pure, and 2° F. boiling range benzene can be used with only a minor lowering of yield. 75–100 lb. of ethyl benzene is obtained per lb. of catalyst, of which 80% is recoverable. Sulphur has no adverse effect on the catalyst. The polyethyl benzenes formed as by-products can be dealkylated to give the monoethyl product. In the latter process, 95% ethyl alcohol and benzene are contacted with an inert solid catalyst saturated with phosphoric acid at 600° F. and 250 lb. pressure. Removal of the water of reaction is a difficulty, but has been attained by reacting only a part of the reactants at a time, removing the water, and recycling the unreacted components. Dehydrogenation of the ethyl benzene to styrene presents the difficulty of controlling the position of the dehydrogenation reaction (nucleus or sidechain) to reduce side products. This is done by preheating the ethyl benzene vapours with an excess of highly superheated steam; the use of catalysts (*e.g.*, oxides of aluminium, vanadium, chromium, and zinc chromate) gives successful results, but the process is not yet commercial. The styrene is prevented from decomposing or discolouring by the addition of 0·005% of inhibitors such as *tert.*-butyl catechol. C. L. G.

497.* Chemical Materials Used in Rubber Manufacture. Anon. *Oil Gas J.*, 26.11.42, **41** (29), 49.—In general, synthetic rubber requires similar types of plasticizers, softeners, accelerators, tack-producing agents, inhibitors, etc., to those used with natural rubber, but the conditions of application, proportions, etc., require investigation. Inhibitors such as dialkyl amines, diaryl or alkylaryl amines, and other amino-compounds, cresols, substituted catechols, hydroquinones, etc., are used to inhibit premature polymerization of butadiene and styrene. Vulcanization accelerators used include guanidine, thiazoles, sulphamines, and thiazolines and zinc dithiocarbamate, overcuring having less effect on the properties of synthetic rubber than on natural rubber. Tack agents used include pine tar, rosin oil, cumar, etc., and softeners used include coal tar, phthalates, sebacates, ricinoleates, aromatic ethers, triacetin, and various proprietary products. Synthetic rubbers being normally stiffer than natural rubber require more control in softening. Aromatic mercaptans are useful as plasticizers. The type of carbon black is very important in synthetic rubber production. The coarse thermal blacks have less reinforcing effect than the finer channel blacks, etc., but give easier processing, better hysteresis, higher rebound, etc. In general, ink and acetylene blacks are preferred for tyre tread stocks, owing to better strength and durability, and the finer thermal blacks and special reinforcing blacks for side walls where heat resistance is of great importance. Less sulphur is required for the vulcanization of synthetic rubber, accelerators such as tetramethyl and thiuram disulphide, and activators such as zinc oxide, fatty acids, etc., being also used. Inhibitors such as butyl and phenyl-β-naphthylamine are used to reduce ageing of the rubber, as well as heat-resistant anti-oxidants. C. L. G.

498.* Raw Materials for Synthetic Rubber Intermediates. W. L. Nelson. *Oil Gas J.*, 26.11.42, **41** (29), 34.—A review is given of the potential sources of supply, and the yields from them of the raw materials required for manufacturing the estimated U.S. requirements of the main synthetic rubber intermediates—viz.: (1) Styrene, 230,000 t.p.a., (2) *iso*butene, 143,000 t.p.a., and (3) butadiene, 710,000 t.p.a. (1) The styrene will be derived mainly from the dehydrogenation of ethyl benzene prepared from ethylene or ethyl alcohol and benzene. 5,400,000 cu. ft. of ethylene p.d. will be required, some possibly from coal gas, but the suggested source is 6,400,000 cu. ft. of ethane (from 53,000,000 cu. ft. of natural gas per day). While the potential production of ethylene is 8,820,000 cu. ft. per day, the difficulty of transfer to central chemical plants renders the production from natural gas more likely. To produce the ethyl alcohol (100,000 gallons per day) as an alternative source of ethyl benzene, 13 million bushels of wheat will be required. The benzene also required (140,000 gallons/day) is more likely to be obtained from coal (43,000 tons/day) than from petroleum. (2) *iso*Butene is derived from petroleum only, the raw materials required being either (*a*) 60,000 brl./day of natural gasoline giving 4900 brl./day of *iso*butane, or (*b*) 16,000 brl./day of natural gasoline, including the isomerization of butane, or (*c*) the cracking

and distillation of 220,000 brl./day of crude oil to give 143,000 tons p.a. of *iso*butene, both direct and via *iso*butane. (3) The butadiene required can be derived from petroleum in several ways—viz., (*a*) by direct dehydrogenation of 28,500 brl./day of butane from 115,000 brl./day of natural gas or 1,270,000 brl./day of crude oil (by the Houdry process-yield 67%), or a two-stage process involving cracking and dehydrogenation of the butenes, or (*b*) by high-temperature pyrolysis of 250,000 brl./day of naphtha or gas oil (from 420,000 brl./day of crude) yields 3·9% or (*c*) by best temperature pyrolysis of 2000 million cu. ft. of natural gas per day to acetylene (2·5% yield), from which acetaldehyde and butadiene can be derived, or (*d*) conversion of ethylene into alcohol, thence into butadiene (yields of 20% based on ethane are claimed). The alcohol required—2 million gallons/day—may alternatively be derived from 260,000,000 bushels of wheat, 10,000,000 tons of molasses, or 32,000,000 tons of sugar beet, cane, or potatoes p.a. Yields of 20–30% of butadiene by direct conversion from alcohol are claimed.

It is considered that ample stocks exist, without disturbing other requirements, of mixed butanes, natural gas, petroleum naphtha, and coal, whereas benzene and alcohol are deficient in quantity. Production of intermediates from petroleum has the advantage of giving rise to other valuable products, aviation gasoline, toluene, fuel oil, etc. The recovery of *iso*butene from cracked gases for polymerization appears to entail large amounts of equipment and high operating costs compared with direct production from, *e.g.*, *iso*butane. C. L. G.

499. Synthetic Rubber from Petroleum. G. Egloff. *Refiner*, December 1942, **21** (12), 114.—(N.B.—As this paper is in the non-continuous section of the *Refiner*, it may not be found in bound volumes of this journal after 1943.) The paper reviews the industrial as well as the technical significance of the synthesis of rubber. Synthetic rubber is compared with its natural prototype. The problems are viewed from war purposes standpoint. A. H. N.

500. Simple Tests for Estimating the Suitability of Mineral Oils as Mosquito Larvicides. W. A. L. David. *Bull. Ent. Res.*, September 1942, **33** (3), 195.—A specification for a suitable anti-malarial oil is given with details of the significance and method of carrying out the tests.

The proposed specification is: (1) specific gravity at 15° C./4° C.; not $>$ 0·950 (*i.e.*, sufficiently below that of water), (2) Not $>$ 5% should distil over at 200° C. (to control loss by evaporation and hence increase of viscosity which may affect toxicity and penetrating properties), (3) viscosity not $>$ 10·0 centistokes, equivalent to 52 secs. Redwood I. or 1·83° Engler at 70° F. (to ensure adequate penetration of the tracheæ), (4) spreading pressure not $<$ 16 dynes per cm. (to ensure that the oil will cover the surface evenly, displacing contaminating films), (5) the films produced by the oil must remain uniform and unbroken for at least 2 hours (some oils give unstable films, breaking up into lenses) and (6) when tested by the described method the oil should kill at least 50% of the larvæ when *Aedes ægypti* are used or 90% when *Anopheles maculipennis* are used.

Appendices are included, giving notes on blending procedure and of the ways in which defects in the product can be overcome, with general information on the average properties of petroleum oils used in anti-malarial oils. C. L. G.

501. The Utilization of Waste Lubricating Oil in Mosquito Larvicides. W. A. L. David. *Bull. Ent. Res.*, December 1942, **33** (4), 235.—The suitability of nine samples of waste lubricating oil from aerodromes for incorporation into mosquito larvicides has been examined. They varied in viscosity from 360 to 2520 secs. Redwood I. at 70° F., and had spreading pressures of 16 dynes/cm. or over, with one exception, which had been filtered, but still contained carbonaceous matter and water. Blends were prepared of 10–15% kerosine, 60% diesel oil, and 28–30% of waste oil to have a viscosity of about 52 secs. Redwood I. at 70° F., and these all showed a spreading pressure of 16 or over with good film stabilities. (The diesel fuel used had a spreading pressure of 16 dynes/cm., so that it does not follow that all waste oil could be used to the above extent with any diesel fuel.) Up to 1% of cresylic acids or crude castor oil may be added to improve spreading pressures, but crude palm, ground nut, coconut, and rape oils induced film instability. The toxicity of the blends against *Aedes*

aegypti was unsatisfactory, possibly owing to the carbonaceous particles in the waste oil clogging the spiracles, and thus preventing spread into the tracheæ. Removal of carbonaceous matter by treatment with fuller's earth increased the kill to satisfactory proportions, but reduced the spreading pressure. To overcome this difficulty tests were carried out with an oil film of twice the thickness (4·4 fluid oz. per 100 sq. ft.), this giving very satisfactory results. High kills at the lower film thickness were also recorded against the more easily oiled Anopheline larvæ. It was established that by reducing the viscosity of blends to about 45 secs. Redwood I. at 70° F., by using 10–20% only of the waste oils, satisfactory spreading pressures, film stabilities, and toxicities could be obtained. It is concluded that blends containing 28–30% of waste oil are not as effective as approved commercial larvicides at the same dosage, but if this is increased from 2·2 fluid oz. to 4–6·7 fluid oz. per 100 sq. ft. (the highest dosage is required only against colicine larvæ), satisfactory results are given. Limiting the waste oil content to 10–20% gives effective larvicides. C. L. G.

502. Memorandum on Measures for the Control of Mosquito Nuisances in Great Britain. J. A. Sinton and P. G. Shute. Ministry of Health Memo 238/Med., 1943.—The habits, distribution, prevalence, and importance to man of the British species of mosquito are described and details given of the recommended methods of treatment of breeding grounds. While the different types require varying treatments, according to habits, breeding places, time of breeding, etc., the following general methods of control are given :—

1. *Against Adult Mosquitoes.* (*a*) Species which hibernate inside buildings are best controlled by spraying with 2–5% solution of carbon tetrachloride in kerosine, or 5% aqueous solution of cresol disinfectant, or preferably pyrethrum solutions in kerosine (100–120 mgms. pyrethrins per 100 c.c.). This should be done in the autumn at the beginning of hibernation and in spring before emergence. (*b*) Preparations containing citronella oil are recommended as mosquito repellents.

2. *Against Larvæ and Pupæ.* (*a*) Breeding places should be filled in, or drained wherever possible, water receptacles being kept covered or emptied and cleaned regularly. (*b*) In ornamental ponds the introduction of goldfish will keep down mosquitoes and in ponds, etc., cutting down vegetation causing shade will help, as will frequent sluicing of dykes, etc. (*c*) Larvæ and pupæ can be suffocated by spreading on the surface of the water special anti-malarial oils such as one part of crude heavy oil to four parts of kerosine. (The addition of 0·2% castor oil will increase the spreading power enormously and 1% of cresol will increase the toxicity.) ¼ oz. of oil per sq. yd. or 15 gallons per acre should be used. Filtered waste crank case oil mixed with 10–20% kerosine and 1–2% castor oil can also be used. For large areas, spraying is the best method of distribution, but for smaller areas the oil may be spread with a bundle of rags or sacking on a stick. Oiling is useful where there is not too much vegetation, high winds absent along the edges of deep ponds and lakes, in prelighting water tanks, etc. Treatment should be repeated every two weeks during the breeding periods. Domestic water containers can be treated with 4 tablespoonfuls of petrol per sq. yd. or if fitted with taps at the bottom with 1½ teaspoonfuls per sq. yd. of liquid paraffin. Chemical larvicides recommended include : (1) sufficient cresol type disinfectant to give a concentration of 1 in 30,000 (economic only for shallow pools, etc.), (2) ½ lb. per acre of Paris green (copper aceto arsenite) mixed with an inert dust (only suitable against Anopheline larvæ, not Culicines), (3) 1½ to 2 gallons per acre of a stock pyrethrum-oil-soap emulsion containing 95 parts light fuel oil, 5 parts pyrethrum extract (containing 2½ grms. pyrethrins per 100 c.c.), 5 parts of coconut oil potash soap and 45 parts of water. This is harmless to fish, water fowl and plant life and as it does not spread well may require to be used in quantities of 6 gallons per acre, if there is much vegetation or floating debris. C. L. G.

503.* Wartime Chemicals from Natural Gas. G. Egloff. *Petrol. Times*, 6.3.43, **47** (1190), 110. *Presidential Address before American Institute of Chemists.*—Dr. Egloff discusses the various chemicals obtainable from natural gas, and in this, the first part of his lecture, synthetic aviation fuels and rubbers receive the most attention. In general, one can say that synthetic rubber is at least equivalent to the natural; the chemist's goal is not necessarily to synthesize a duplicate of natural rubber, but it is certain that whatever properties rubber has that are needed will not only be

duplicated but radically improved and new ones added. Synthetic rubber is superior to natural rubber in gasoline, oil, and chemical resistance. The synthetic product is more stable to light and air and has greater wearing properties. Some trucks using synthetic rubber tyres have gone over 35,000 miles. Side-wall tyre strength is greater, meaning greater safety and better road gripability. The latter property has been tested out thoroughly on wet and muddy roads. Tests on hills with different trucks have shown that the synthetic rubber-tyred vehicle goes up a hill with very little side-slipping, whereas the tyres of natural rubber slipped all over the road. On curves, when operating the car at high speeds, the synthetic tyre is safer than the natural. With the number of research men in the field of synthetic rubber, with expenditure of millions of dollars yearly, one can feel confident that synthetic rubber tyres will evolve with a life of at least 100,000 miles, or, expressed another way, the tyres may well outlive the motor-car. The author believes that synthetic rubber will play a permanent part in the life of the U.S.A. A. H. N.

504. Synthetic Drying Oils. H. J. Wolfe. *Paint Manufacture*, March 1943, **13** (3), 59.—Much progress is being made in the improvement of slow drying oils by production of a conjugated double bond system by (*a*) conversion of isolated double bonds in the fatty oil to conjugated bonds, (*b*) dehydration of hydroxy acids in oils which contain them, and (*c*) dehydrogenation of oils by halogenation followed by dehydrohalogenation. A synthetic drying oil (marketed as S.D.O.) of particular interest is produced by the partial polymerization of divinylacetylene and the tetramer of acetylene, the product being prevented from completing the polymerization by dilution with solvents. On evaporation, polymerization is completed, being accelerated by oxygen and light, giving a hard transparent, amber coloured resinous film. The dried film is impervious to moisture, oils, ammonia and dilute acids, but lacks stability and has poor adhesion when pigmented. The synthetic oils obtained by co-polymerization of phthalic anhydride, glycerine, oils, and oil acids (alkyds) have exceptional toughness, flexibility, and adhesivity and require less oxygen for drying. It is said that a commercial process was in operation in Russia prior to the war for the production of drying oils from petroleum by chlorinating a hydrocarbon fraction from naphthene base crude and reacting it with another fraction which has been oxidized and saponified. Products obtained experimentally from cracking residues may be treated with catalysts to yield synthetic drying oils, but they have dark colours and unsatisfactory weather resistance. C. L. G.

PUBLICATIONS RECEIVED.

Institution of Automobile Engineers, Proceedings. Vol. XXXVI. Session 1941–1942. Pp. 513. Institution of Automobile Engineers, 12, Hobart Place, London, S.W.1.

Among the twelve papers presented before the Institution during the session 1941–1942 the following may be mentioned as being of particular interest to the Petroleum industry :—

The Performance of a Converted Petrol Engine on Producer Gas. (J. Spiers. Report of the Automobile Research Committee.)

Engine Bearing Temperature. (J. Spiers. Report of the Automobile Research Committee.)

British Standard No. 76 : 1943.—Tars for Road Purposes. Pp. 12. British Standard Institution, 28, Victoria Street, London, S.W.1. Price 2*s.* net.

A war emergency specification which takes into account the considerable advance which has been made in the development of modern road tars.

The road tars are divided into three types, based on road requirements, and not on viscosity as heretofore; type " A " having the most rapid setting properties, type " C " being slow setting, and type " B " occupying an intermediate position.

The viscosity range has been expanded, and a new system of indicating viscosity has been introduced, namely, the Equi-Viscous Temperature.

Changes have been made in the schedule of requirements, and the applicability clause now contains sufficient information to enable engineers to choose the tar they require for any purpose.

British Standard No. 463 : 1943.—Sockets for Wire Ropes for General Engineering Purposes. Pp. 12. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2*s.* net.

The sockets specified are of normal type for general engineering purposes, and are efficient and permanent terminal attachments for wire ropes, where other methods are precluded. Special attention is directed to the short parallel length and orifice radius at the smaller end of the " basket " in both the open and closed type sockets specified.

Reference is made to the following British Standards :
B.S. 24. Part 4 : 1930, Specifications 8 and 9.
B.S. 643. Capping Metal for Steel Wire Ropes.

British Standard No. 796 : 1943.—Rubber Hose with Cotton Braided Reinforcement. Pp. 18. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 3*s.* 6*d.* net.

War Emergency Standard including specifications for oil, grease, and Solvent Hose, High Pressure Hose for use with Oil Emulsions, etc., and requiring reference to the following British Standards :

B.S. 903. Methods of Testing Vulcanized Rubber.
B.S. 924. Rubber Hose with Woven Fabric Reinforcement.

British Standard No. 924 : 1943.—Rubber Hose with Woven Fabric Reinforcement. Pp. 20. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 3*s.* 6*d.* net.

British Standard No. 1102 : 1943.—Rubber Suction and Discharge Hose with Woven Fabric and Wire Reinforcement. Pp. 26. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 3*s.* 6*d.* net.

British Standard No. 1103 : 1943.—Cotton Fabrics for the Reinforcement of Rubber Hose. Pp. 8. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2*s.* net.

War Emergency Standard dealing with cotton fabrics for use in the manufacture of all types of wrapped hose.

British Standard No. 1041 : 1943.—Temperature Measurement. Pp. 76. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 12*s.* 6*d.* net.

A temperature measurement code divided as follows: (1) General, (2) Expansion Thermometers, (3) Electrical Resistance Thermometers, (4) Thermocouples, (5) Radiation Pyrometers, (6) Electrical and other Auxiliary Instruments used in temperature measurement, (7) Change of State of Testing Body, (8) Calorimetric Measurement of Temperature, (9) Temperatures in the Interior of Solids, (10) Surface of Solids, (11) Liquids, (12) Gases, (13) Calibration Methods.

References are made to the following British Standards:—89, 593, 619, 691, 692, 695, 791.

British Standard Code of Practice No. CP1 : 1943.—Protection of Structures against Lightning. Pp. 30. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 3*s.* 6*d.* net.

It is considered that this code of practice will meet a wide demand for authoritative guidance on the subject of protection against the effects of lightning.

British Standard No. 1042 : 1943.—Flow Measurement. Pp. 64. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 12*s.* 6*d.* net.

A code setting out the conditions governing the design installation, and use of standard pressure-difference devices in order to obtain consistent and generally acceptable results from commercial instruments.

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Geology and Development.

504.* Stratigraphical Analysis and Environmental Reconstruction. T. G. Payne. *Bull. Amer. Ass. Petrol. Geol.*, November 1942, **26** (11), 1697–1770.—In stratigraphy the naming of formations, correlation charts, and faunal lists are not enough, but must be supplemented by palæoecological study of sedimentary types and fossils. A scheme for rapid analysis of data bearing on mode and environment of origin is outlined with special reference to the crinoidal phase of the Grand Tower limestone (Middle Devonian) of Ozora, Ste. Genevieve County, Missouri.

Field description, thin sections, polished sections, binocular study of fragments, chemical tests, sieve and pipette methods, all contribute to petrographical analysis. Genetic classification then distinguishes between autochthonous and allochthonous components. The former may be either syngenetic or epigenetic, according as they are formed contemporaneously with or after the rest of the rock. Account must also be taken of the manner in which each component has been formed. Attributes of the component fragments to be noted are: composition; internal structure; size; percentage of total volume; shape and degree of rounding; surface texture—whether rough, smooth, frosted, etched, striated, pitted; relative position of components; random, parallel, or imbricate orientation of fragments.

Mass properties to be considered are colour, chemical composition in bulk, acid

solubility, interstitial cementation, mass texture, packing, porosity, permeability. Plasticity, hygroscopicity, fusibility, and specific gravity are of less stratigraphical importance. Mass textures are either fragmental or crystalline. In the latter case, the effects of chemical precipitation, secondary recrystallization, and secondary crystalline growth must be distinguished. For instance, orthoquartzite, due to growth of secondary quartz, is to be discriminated from metamorphic, recrystallized paraquartzite.

Syngenetic sedimentary structures to be looked for include cross-bedding and other types of stratification, bioherms and biostromes, markings by rain-drops, ice-crystals, wave-ripples, swashes, and animal tracks, tensional mud-cracks, compressional ice-rucking, slumps. Epigenetic structures are solutional, like stylolites; compressional, like folds, faults, cone-in-cone or tensional, like faults and joints.

Palæontological analysis, for which Simpson and Roe's *Quantitative Zoology* (1939) may serve as an introduction, begins by distinguishing life assemblages and death assemblages. In different sediments, prevalent genera and types of gross external morphology (*cf.* Lamont, *Ann. Mag. Nat. Hist.*, Ser. 10, vol. xiv, 1934) should be recorded. The size of the organisms is also useful as an index to factors of salinity, temperature, turbidity, dissolved gases, *e.g.* abundance or poverty of oxygen, in the environment. Dwarf faunas may be due to stunting or to weeding out of large species by selection (*cf.* Shimer, *Amer. Nat.*, vol. xlii, 1908). Presence of broken material, space distribution, and estimates of the numbers of different species in faunules should also be studied, with the *caveat* that short-lived animals, or those with an annual moult, may produce a larger number of preservable hard parts, than their contemporaries.

Payne also analyses the environmental factors in the provision, transport, and deposition of sedimentary materials. He propounds rules such as that "the sea will tend to produce, under given environmental conditions, sediments of similar textural character regardless of differences as to source and type of material being supplied," and that "under given environmental conditions the sea will tend to produce organic assemblages of similar nature regardless of differences as to species and genera available." It is desirable to know the character, slope, and degree of compaction of the substratum, also the direction of movement of the sediment and of the medium. Bottom currents can be estimated from the range of size of particles by means of Hjulstrom's size-velocity curves for erosion and deposition (*Recent Marine Sediments*, A.A.P.G., 1939, p. 13). Conjectures should be attempted concerning depth of water, light intensity, and geographical position. Limiting data can be obtained from the "ecologic valence" of different fossils. Thus, the valence of a species of coral might be: salinity, rather high; mean temperature, 60–85° F.; current velocity under 100 cm./second; dissolved oxygen over 4·0 ml./L; light intensity, above some measurable value.

The chemical changes undergone after deposition, in the zones of weathering, diagenesis, and anamorphism, fall also to be considered, together with the history of the sediment during diastrophic movements. A. L.

505.* Two More Ordovician Well-core Graptolites, Crane County, Texas. C. E. Decker. *Bull. Amer. Ass. Petrol. Geol.*, November 1942, **26** (11), 1771–1775. From McKnight No. 4, Crane County, at 6458 ft. and 6479 ft. respectively *Callograptus tenuissimus* Decker sp. nov. and *Didymograptus* cf. *bartrumi* Benson and Keble are described. The former would probably fall in the sub-zone (a) of the *D. extensus* zone, as Elles indicates that dendroid graptolites are most abundant in that sub-zone which is about the middle of the Skiddaw slates. The nearest counterpart is *C. tenuis* from the Upper Arenig. *D.* cf. *bartrumi* compares with *D. bartrumi* which in the Lower Ordovician of New Zealand is associated with *Tetragraptus fruticosus*. It also approaches *D. nitidus*. A. L.

506.* Stratigraphy of North Dakota. N. Ballard. *Bull. Amer. Ass. Petrol. Geol.*, November 1942, **26** (11), 1776.—In the Carter test and Prairie Oil and Gas Company's Armstrong No. 1 (= Steele of Dr. Kline), beds with red and green sandy shales and a chert conglomerate, ascribed by Kline (*Bull. A.A.P.G.*, March 1942) to the Devonian, are probably partly Jurassic and Triassic. Permian or Pennsylvanian may also be represented. A. L.

507.* **Development and Use of Engineering Geology.** (With a Foreword by Paul Weaver and others). F. A. Nickell. *Bull. Amer. Ass. Petrol. Geol.*, December 1942, 26 (12), 1795–1826.—The hade and direction of fault planes often depend on the nature of the rock formation. Faulted areas usually contain a vast number of individual faults. A structural contour map with unbroken lines, is, therefore, at best an idealization.

Studies of the sites of the Boulder, Grand Coulee, Shasta, Friant, and Marshall Ford dams in North America are used to illustrate such problems. The factors taken into account are :

(1) Local geology, including seismicity.
(2) Character of formations at site.
(3) Thickness of cover or overburden.
(4) Physical stability of rocks.
(5) Possible seepage and detailed features requiring special treatment.
(6) Available construction materials.

Trial holes, seismographic methods—seismic velocity is related to elasticity—migration of tracing fluid between holes, determination of compression and shear strengths, and petrographical and sieve analyses are all of significance.

Boulder Dam, Nevada and Arizona.—The dam of arch-gravity plan is built on the Dam breccia, a Tertiary tuff with monzonitic porphyry fragments, the minimum ultimate strength of which is 9260 lb./sq. in., and maximum 22,400 lb./sq. in. Upper parts of the abutments rest on latite flow-breccia which can carry reduced stresses. The site is jointed and faulted, with a channel 80 ft. deep, due to late Glacial rejuvenation, along the centre of the floor of the gorge. Filling of the reservoir resulted in slight isostatic settlement, and certain faults were revitalized. Microseisms of intensity IV on the Mercalli scale (1931) have been recorded on the faulted margins of depressed blocks some miles from the dam.

Grand Coulee Dam, Washington.—This straight-gravity dam, containing 10 million cu. yds. of concrete, which develops power partly used to pump water into a high-level system of irrigation canals, is on Jurassic coarse-grained granite with intrusions of fine-grained granite and of Tertiary basalt. There are crush-planes. Overburden is of Glacial clays and sand, and of stratified alluvium. There was much slumping when, after the glaciation, the Columbia river excavated the valley-fill, the remaining part of which had to be stabilized by drainage, partial unloading, and dumping of rock along the toe. Faults are widely spaced and probably of Tertiary date. They influence weathering and erosion, and had to be cleaned out below the level of the surrounding floor, filled with concrete, and grouted.

Marshall Ford Dam, Texas.—This straight-gravity structure controls flooding on the Colorado river and serves hydro-electric generation. It rests on nearly horizontally bedded Comanche (Lower Cretaceous) sediments, including sandy limestone, limestones, and shales. Shaly layers slacked on exposure and had to be trimmed immediately before concrete was put in position. Some strata tended to slide under the downstream thrust of the dam. To prevent squeezing of soft material and to obviate seepage, pairs of tunnels were constructed through the doubtful beds in each abutment, and these drifts were then filled with concrete and grouted. Grouting was also used to fill cracks and cavities under the foundations. Artesian flow in the Hensel "sands" at a depth of 200 ft. indicates relative imperviousness of the beds flooring the reservoir.

Shasta Dam, California.—A curved-gravity dam, to be completed in 1944, is intended to control floods on the Sacramento river and regulate the salinity in San Francisco bay, and to serve for power generation. The foundations are on agglomerate, conglomerate, and lava of the Copley formation (pre-Middle Devonian). Intrusions of Dacite porphyry and quartz-diorite are of Jurassic age. Local faults are inactive, but slight earthquakes from Mount Lassen have been calculated for. Weathering is far advanced in the Devonian meta-andesite, and over 3 million cu. yds. of porous material had to be stripped away. Faults and schistose zones with gouge had also to be treated to avoid differential settlement and seepage. Drainage and inspection tunnels have been driven for examination of crush zones and concreting when the reservoir is filled. Strength of the meta-andesite varies from 535 to 35,400 lb./sq. in.

Friant Dam, California.—Where the San Joaquin river leaves the western foothills of the Sierra Nevada, this straight-gravity dam impounds irrigation water. The foundation is mainly quartz-biotite schist with many Jurassic intrusions of pegmatite and dioritic dykes. In general, planes of schistosity dip downstream and strike at a small angle to the axis of the dam. Weathering becomes more intense as one ascends the valley slopes. Faults and seams with unsound rock were investigated by shafts, tunnelled, concreted, and grouted. Strength of the schist varies between 1460 and 20,680 lb./sq. in. Unweathered specimens break along planes according to the orientation of the strain ellipsoid, regardless of the direction of schistosity. A. L.

508.* Calculating the True Thickness of a Folded Bed. G. D. Hobson. *Bull. Amer. Ass. Petrol. Geol.*, December 1942, **26** (12), 1827.—Hobson gives an account of the errors which may arise in calculating true thickness of a bed from vertical thickness multiplied by the cosine of the angle of dip. The calculation becomes less accurate the greater the dip and the greater the ratio of the true thickness of the bed to its radius of curvature. A. L.

509.* Geology and War. P. H. Price and H. P. Woodward. *Bull. Amer. Ass. Petrol. Geol.*, December 1942, **26** (12), 1832.—The strategic applications of geology are numerous. It can be used in the interpretation of terrain for defence and attack, since the geologist understands earth-features better than anyone else, and knows how to forecast them in unfamiliar areas from geological publications, photographs, and maps. Most overseas regions have been examined by geologists now resident in the U.S. The geologist can also point out testing grounds where duplicate conditions exist for anticipated campaigns. He can advise on off-shore, beach, and riverine topography, on soil and likely vegetation, on sites for roads and road-mending materials. He can help in appraising the value or vulnerability of fortifications, camps, batteries, aerodromes, and on the accessibility of water and mineral resources.

Geological advice should be obtained in the conversion of ground to military use for trenches, tank traps, tunnels. Quarrying and the prevention of slumps and debris-slides are also in the geological ambit, and the question of which swamps and quicksands can be reclaimed and which not. Effect of bombardment on different rock types, safety of underground workings as refuges, retention of gas in different rocks and soils, restoration of shelled territory and of oil-wells, are all matters for geological investigation.

Geologists can prospect for brick clays, marl ballast, sand, aggregate for concrete, do map-making and surveying, solve water-supply problems and those of sanitation and interment.

Camouflage and its detection are a new sphere for the geomorphologist who knows so well the natural appearance of a landscape.

Geophysicists can be employed to detect mines, pipes, and metallic underground installations.

The authors recommend that a geological organization should be set up for the application of geological knowledge "in the post-war settlement, and in possible future military and naval undertakings." There should be sustained study of geology in relation to fortification. Handbooks of Military Geology should be prepared. A more intensive search for new sources of raw materials both at home and abroad is necessary now, and will be equally necessary in the future. A. L.

510.* War Trims World Crude Production Ten Percent. Anon. *Oil Wkly*, 1.2.43, **108** (9), 44.—The 1942 world oil production was about 10% below the 2,226,836,000 brl. produced in 1941. This decline reflects in particular the declines in U.S.A., Russia, and Venezuela, as well as those in countries with smaller outputs. The 1942 estimates are rather uncertain owing to the absence of official statistics on many countries. It is possible that both Russia and Venezuela have experienced sharp production declines. Submarine warfare greatly curtailed Venezuelan oil exports early in 1942, but the exports probably rose later in the year.

The Maikop field in Russia was put out of action in 1942, and normal oil movements from Grozny and the Baku district were disrupted by the German invasion. In the

Netherlands Indies and Burma the wells were put out of action before the Japanese invasion, but the Japanese captured some of the British Borneo wells intact.

A table gives the annual crude oil production by countries since 1857. G. D. H.

511.* Crude Reserves Drop as Less Oil is Found than Produced. W. L. Baker. *Oil Wkly*, 1.2.43, **108** (9), 48.—In 1942, for the first time for nearly a decade, the volume of new oil found in U.S.A. failed to equal the production, although the rate of discovery of oil has been declining for the past four years. At the end of 1942 the U.S. reserves were estimated to be 19,325,899,000 brl., a decrease of 263,397,000 brl. during the year. The proven new oil found in 1942 was 1,121,950,000 brl., whereas the production was 1,385,347,000 brl.

The various methods of rating oil-discovery efficiency agree in showing that fewer and fewer barrels of oil are being found, although prospecting efforts are being maintained at high levels. Hence the decline in the discovery of reserves has been due to a failure to find as prolific pools as in previous years. This creates the fear that the nation's larger oil accumulations may have been found, with the consequence that it will be necessary to drill more and more wells if enough oil is to be found to offset producing rates. The amount of oil found in the last three years was little more than half that found in the preceding three years, although more wildcats and more dry holes were drilled, and more new fields were discovered. An average of 1,661,423,000 brl. of new oil was found annually during the past three years, compared with 3,058,239,000 brl. annually during the preceding three years. The average amount of oil found per new field or new horizon was 3,057,830 brl. for the 1940–1942 period, and 7,293,098 brl. for the 1937–1939 period. In 1939 929,659 brl. of oil was found per wildcat, and in 1942 only 354,374 brl. per wildcat.

Most of the 1942 new oil was found in the south-western States, and this amounted to 71% of the total discovered and developed during the year. This region produced 50% of the U.S. oil in 1942, while its discoveries exceeded its production by 113,474,000 brl. Texas now has 57·1% of the U.S. unproduced oil. The Louisiana reserves amount to 1,371,367,000 brl., or 7·1% of the U.S. total. Arkansas has 343,715,000 brl. of reserves. The reserves of Oklahoma, Kansas, and Nebraska fell during 1942, and the same was true of Illinois and California.

Tables give the U.S. reserves discovered for the period 1859–1899, for five-year periods from 1900 onwards, and for separate years from 1935 onwards, with the oil produced in these periods, accumulated reserves, dry holes, and wildcats completed, new fields and pays found, and the average number of barrels of oil found and developed per year, per dry hole, per wildcat, and per new field or per new pay. The reserve trend is analysed by States and areas for the past six years. G. D. H.

512.* Further Slight Decline in Drilling Foreseen for 1943. R. L. Dudley and E. Sterrett. *Oil Wkly*, 1.2.43, **108** (9), 57.—It seems probable that 18,574 wells will be drilled in 1943, inclusive of water-input and secondary recovery wells. There may be 3289 wildcats. These figures show 2250 fewer wells than in 1942, and a wildcat total well below the 4500 desired by P.A.W. An increase in price of crude oil or a relaxation of the restrictions on materials and equipment could, and probably would, mean a large increase in operations. Altogether it is difficult to forecast the year's operations with certainty.

It is reasonably certain that more crude will be needed in 1943 than in 1942. Also the South-western States will probably be called upon to deliver more oil than last year, partly because of a falling off of Illinois' production and the inability of Oklahoma materially to increase its output. Pipe-line construction will facilitate the movement of oil from the South-west. Illinois' production fell 140,000 brl./day during 1942, despite the State's most active wildcatting ever.

P.A.W. is counting on 16,500 wells other than water-input wells, with 4500 wildcats included, but these figures differ markedly from those reached after consulting the operators.

A table shows by States the number of new wells drilled and the number of wells deepened in 1942, with a forecast of the number of new wells in 1943; and the 1942 footage and the 1943 predicted footage.

The companies have indicated that if the material and price situations were improved, the 1943 wells would number almost as many as were drilled in 1941.

Canada, Mexico, and South America will account for the bulk of the drilling outside U.S.A. in 1943. Argentina's crude requirements exceed her production, and political considerations will determine to a large extent the amount of equipment which she will receive in 1943. Venezuela's 1943 activity will depend on the export situation.
G. D. H.

513.* Wildcat Results in 1942 Unsatisfactory. L. J. Logan. *Oil Wkly*, 1.2.43, **108** (9), 67.—Many fewer wildcats than normal were drilled in U.S.A. in 1942, and the discoveries were materially less in number than was hoped for under the drilling programme laid down by the Government. The discoveries were not as numerous as was considered essential for properly maintaining reserves. 3166 wildcats were drilled out of 21,412 wells—a greater proportion of wildcats than usual. The designed programme required 4000 wildcats, finding 624 new oil sources and 116 new gas areas. Actually there were 466 oil discoveries, including 15 distillate finds, and there were 57 gas discoveries. 348 new fields were found, of which 288 gave oil, 47 gas and 13 distillate. Of the new pays 163 gave oil, 2 distillate, and 10 gas.

The average depth of the discoveries was 4222 ft. The new fields had an average depth of 3862 ft., with the oil-fields averaging 3837 ft., the distillate fields 7997 ft., and the gas-fields 2870 ft. The new pays were of an average depth of 4938 ft., with the oil-pays averaging 4974 ft., the distillate pays 6192 ft. and the gas-pays 4110 ft. The average depth reached in the 2643 unproductive wildcats was 3515 ft.

Tables give by States and districts the numbers of new pays and new fields, and the average depths of the discoveries in each of the years 1936–1941, inclusive, the total discoveries in 1942 and their average depth; the numbers of productive and unproductive wildcats in 1942, with the average depths; and the number of oil, gas, and distillate discoveries, with the average depths. G. D. H.

514.* Footage Drilled Declines Less than Volume of Completions. Anon. *Oil Wkly*, 1.2.43, **108** (9), 70.—The average depth (3038 ft.) of all wells drilled in the U.S.A. in 1942 was slightly greater than the 1941 average (2963 ft.). The total 1942 footage was 31·8% less than the 1941 footage, and amounted to 65,056,261 ft. for 21,412 wells.

Illinois, Kansas, Oklahoma, North and West Central Texas, Ohio, Indiana, Kentucky, Montana, and Wyoming are below the national average in their mean drilling depths, and all these States had substantial or sharp declines in drilling activity. The relatively heavy drilling in the Appalachian States, with their comparatively shallow wells, tended to keep down the national average depth. In Pennsylvania, the 1942 wells averaged less than 1700 ft., and New York wells were even shallower, and were 10% more numerous than in 1941.

In 1942 588 old wells were deepened, adding 243,176 ft. of drilling depth. In Texas the average deepening operation was 488 ft., in Oklahoma 263 ft., in Kansas 241 ft., and in California 423 ft. per well.

Over 3,000,000 ft. of 1942 drilling was for water-input, gas-input and salt-water disposal wells. The water-input wells were mainly in Pennsylvania and New York, and aggregated 3,251,122 ft. The gas-input wells were largely in North Texas, Oklahoma, and Illinois.

18,567 new wells were drilled strictly for oil or gas in 1942, with a total footage of 61,362,202 ft. The average drilling depth in wildcat tests was 3516 ft. per well, and was considerably greater than the average in proven fields.

Tables give by States the number, total footage, and average depth of new wells in 1942, with subdivisions according as the wells are in fields, or are wildcat, water-input, gas-input, or salt-water disposal wells; the total new wells in 1942, the total wells in 1941 and the wells drilled deeper in 1942. G. D. H.

515.* One Third Fewer Wells are Completed During 1942. Anon. *Oil Wkly*, 1.2.43, **108** (9), 75.—One third fewer wells were drilled in U.S.A. in 1942 than in 1941, and they totalled 21,412. There were 5638 dry holes, 26% of the total, a somewhat higher percentage than in 1941, when there was comparatively close spacing. 18,567 new wells were drilled for oil or gas, apart from deepenings. Of these, 11,059 found oil or distillate, and 1870 found gas. There were 2995 dry holes in fields and 2643 dry wildcats. Deepening operations were sharply curtailed in 1942, when they

numbered 588 against 823 in 1941. The deepening operations were mainly in Illinois, Kansas, Oklahoma, and North and West Texas. 2257 miscellaneous wells were completed in 1942. They were largely water-input wells drilled in Pennsylvania and New York. North Texas had 14 water input wells.

Tables give by States and districts the oil, gas, and distillate completions in 1941 and 1942; the total producing wells in 1941 and 1942; the numbers of dry holes in 1941 and 1942, and the numbers of dry holes in fields and among wildcats in 1942; the numbers of gas-input, water-input, and salt-water disposal wells in 1941 and 1942; and the numbers of wells deepened in 1941 and 1942, with separation according to whether they were dry, or found oil or gas. The total gas, oil, distillate, water-input, gas-input, deepened wells, and dry holes are given for the period 1859–1922, and for each year since 1922. G. D. H.

516.* Usual Growth in Number of Producing Wells Retarded. Anon. *Oil Wkly*, 1.2.43, **108** (9), 78.—In 1942 there were 407,257 producing oil wells in U.S.A., an all-time high, but the net gain of 3675 wells in 1942 was only 42% of the average annual gain for the decade 1931–1941. The failure to maintain the normal expansion in the number of producing wells in 1942 was primarily the result of curtailment in drilling new wells to replace depleted wells, and not so much because of premature abandonment. During 1942 7279 wells were abandoned, compared with 9406 in 1941. In California in 1942, as in 1941, there was a large-scale revival of idle wells.

Transport difficulties caused drastic curtailment of production in the South-western States, and this was largely responsible for the U.S. average production per well being 9·3 brl./day in 1942 against 9·7 brl./day in 1941.

Tables give the number of producing oil wells at the end of each year from 1921 onwards, with the average daily production per well; the numbers of flowing wells and wells on artificial lift at the end of 1941 and 1942 by States and districts, with the average production per well per day in 1941 and 1942. G. D. H.

517.* War Disrupts Upward Rise in United States Crude Output. Anon. *Oil Wkly*, 1.2.43, **108** (9), 80.—1,385,347,000 brl. of oil were produced in U.S.A. in 1942, only 1·3% less than the 1941 output, in spite of the war's interference with transport and supplies. The market value of the crude was 3% above the 1941 figure, giving an average price of $1·17 per barrel.

A table gives the annual production by States since 1859. G. D. H.

518.* Deeper Producing and Drilling Records for Several Districts. Anon. *Oil Wkly*, 1.2.43, **108** (9), 84.—Although the world production- and drilling-depth records have remained unchanged since 1938, both records were established during 1942 in several districts of U.S.A. New producing-depth records were established in West Texas (10,364 ft.), East Texas (10,212 ft.) and South-west Texas (10,168 ft.). On the Texas Gulf Coast the producing-depth record went to 11,815 ft., in North Texas to 7444 ft., in West Central Texas to 4555 ft., and in North Louisiana to 10,546 ft. New Mexico's deepest production is helium at 6950 ft. The first 10,000-ft. test has been drilled in Arkansas, production having been found at 10,477 ft.

A table gives the depth records in the various districts, with the depth, year, formation, and well location. G. D. H.

519.* East Texas Leads U.S. Fields in Both Cumulative and Current Production. Anon. *Oil Wkly*, 1.2.43, **108** (9), 88.—Only about 50 U.S. oil-fields have so far yielded more than 100,000,000 brl. of oil, although many others are approaching this figure. East Texas has given 1,821,593,932 brl. of oil since 1930, more than any entire State except Texas, California, and Oklahoma. The Seminole area has produced more than 1,000,000,000 brl., but this area is formed of numerous closely related pools, some of which have given over 100,000,000 brl. each. Midway-Sunset has produced nearly 1,000,000,000 brl., and Coalinga, Long Beach, Santa Fe Springs, and Oklahoma City about 500,000,000 brl. each.

East Texas also leads in current daily average production, in spite of proration, and was providing 350,000 brl./day at the end of 1942. Next in magnitude as regards current rate of production is Wilmington, with almost 100,000 brl./day. Coalinga, Oklahoma City, Tinsley, and Midway-Sunset are producing over 50,000 brl./day each.

Tables list the fields which lead in current daily average production, giving the discovery year, number of producing wells, and daily average production for the field and per well at the end of 1942; and the fields which have produced over 100,000,000 brl., with the discovery year, cumulative production, and production in 1941 and 1942.
G. D. H.

520.* New Fields and Pays Found in 1942. Anon. *Oil Wkly*, 1.2.43, **108** (9), 97.—348 new fields and 175 new pays were found in 1942. In 1941 there were 346 new fields and 267 new pays.

Tables give the new discoveries by States, with subdivisions according as they are oil-fields, gas-fields, gas-distillate fields, new oil-pays, or new gas-pays, with the name, county, company, well location, and date of completion of discovery well; name, character, and age of producing formation; total depth and completion horizon; initial production, method, and choke; oil gravity. G. D. H.

521.* Producing Oil Wells, Crude Oil Production, and Well Completions in U.S. Fields. Anon. *Oil Wkly*, 1.2.43, **108** (9), 129.—Tables give by States, with the fields arranged alphabetically under counties, the following data: date of discovery; number of oil-wells producing at the end of 1942, with the numbers flowing and on artificial lift; the daily field and average well production at the end of 1942; the 1942 oil production and the cumulative production up to the end of 1942; the number of new wells completed in 1942, with subdivisions according as they are oil-wells, gas-wells, distillate wells, water-input wells, gas-input wells, water-disposal wells, or dry wells; the number of old wells drilled deeper in 1942, subdivided according as they are oil, gas, or dry wells.

Summary tables give the same data for States, and in some cases for State subdivisions. G. D. H.

522.* P.I.W.C. Report on Reserves. Anon. *Oil Wkly*, 8.2.43, **108** (10), 42.—The 1942 oil discoveries in U.S.A. may ultimately account for a maximum possible addition to reserves of 800,000,000 brl., according to W. B. Heroy, P.A.W. Director of Reserves. That would be only 58% of the 1942 production. The proven reserves developed in new fields and horizons amounted to 178,420,960 brl., with proven undeveloped reserves of possibly 241,147,652 brl. 261 new fields were found in 1942, averaging 1,600,000 brl. in reserves per field.

1,385,000,000 brl. of oil were produced in U.S.A. in 1942.

It is forecast that only 16,000 wells will be drilled in 1943, but wildcats may be 20% more numerous than in 1942, when there were 3045 exploratory wells. 5512 or 31% of the 1942 completions were dry, compared with 7025 or 24% dry in 1941. 83·8% of the 1942 wildcats were dry.

A table gives by States the number of new fields found in 1942, with the reserves (proved producing, proved undrilled, total proved, and maximum possible reserves), together with similar reserve data for new horizons. G. D. H.

523.* January Drilling 40% Below Year-Ago Mark. Anon. *Oil Wkly*, 8.2.43, **108** (10), 46.—In the four weeks ended 23rd January, 1943, there were 40% fewer well completions in U.S.A. than in the corresponding period a year ago. The average rate of well completion in the four weeks ended 23rd January, 1943, was 342 per week. California had 4%, Kentucky 64%, and New York 8% more completions than in the corresponding period of 1942, whereas Arkansas had 12% fewer, Ohio 26% fewer, and Indiana 25% fewer than a year ago. 676 of the January completions were oil-wells, 3 distillate wells, 124 gas-wells, and 131 intake and other wells. 34 oil-wells were deepened, and there were 401 dry wells.

Tables give by States and districts details of the well completions in January 1943, with the total wells in January and December 1942 for comparison; also the status of the rigs on 1st February, 1943. G. D. H.

524.* Wildcatting Results Continue Unfavourable During January. Anon. *Oil Wkly*, 22.2.43, **108** (12), 11.—212 wildcats were completed in U.S.A. in January 1943, against 201 in December 1942, but the number was considerably below the figures

for January, October, or November 1942. Of the 212 wildcats, 37 found oil or gas, resulting in the opening of 14 new oil-fields, 5 new gas-fields, and 18 new oil horizons. Not only was the number of successful wildcats in January 1943 smaller than is desirable, but the quality of the discoveries was predominantly low. Two-thirds of the discoveries were in States and districts where discoveries frequently represent limited reserves—namely, Illinois, Indiana, Kansas, Michigan, and North and West Central Texas.

During January 1943 Texas led in wildcat activity, having 61 wildcat completions with 16 finding oil and three gas. The percentage success was 31, compared with the national average of 20% of successes. There were four new oil-fields and five extensions. The Stowell field was extended 2 ml., and this Frio sand-field promises to become a major reserve. Illinois had two new fields, three extensions and eight new horizons among 36 wildcat completions. The Friendsville field has 4 producing horizons, the McClosky having been added to the list. Iola has a third producing horizon in the Weiler formation. A 2000-brl. well has been completed in the Blairsville field, and a Christian County test, 30 ml. from the nearest production, has swabbed a little oil with water from the Devonian at 1905–1908 ft.

Three new fields were found in Kansas out of 37 wildcats. The Hunter discovery, with a potential of 3000 brl./day from the Mississippian, seems to be the best. Two Hunton fields and a Wilcox field were opened in Oklahoma, while Michigan had a new oil-field, a new gas-field, and an extension, but none of these appears to be important.

Three Californian wildcats have had good shows, one being 2½ ml. from Coalinga Nose. There was one gas extension.

Tables set out the results of wildcatting in January 1942 and January 1943, by States and districts, and there is a list of the discoveries in January 1943, with the location, dates of spudding and completion, total depth, completion depth, producing formation, method, rate and choke, oil gravity, type of structure, and method of discovery. G. D. H.

525.* New California Wells Have Smaller Producing Ability. E. S. Bunch. *Oil Wkly*, 22.2.43, **108** (12), 33.—The first hundred wells completed in California in 1943 had a combined potential of 10,825 brl./day, whereas the first hundred completed in 1942 netted 53,614 brl./day. The first hundred completions in 1943 accounted for 332,340 ft. of drilling, while the first hundred in 1942 accounted for 571,691 ft. Not a single 1943 completion has had an initial producing capacity of 2000 brl. or more per day, but there were 5 such wells among the first hundred 1942 wells. In 1943 only 2 wells have been in the 1000–2000-brl. class, compared with 18 in 1942.

So far in 1943 only a negligible quantity of new production has been developed, apart from a possible major field in the Coalinga area, a new deep sand strike in the Del Valle region, a surprise extension in the Santa Maria Valley field, and possible production in the Bardsdale area.

The demand for Californian oil has increased during the war, and while production has risen substantially, withdrawals from storage have had to be made. The demand is now over 800,000 brl./day, and may soon exceed 1,000,000 brl./day. Hence there must be intensive drilling in producing fields, and even more intensive exploratory drilling.

Concentration on drilling for heavy crudes is partly responsible for the poorer individual yield of wells this year. Fresh fuel-oil supplies can at present be obtained only by drilling up final locations in old shallow fields, most of which have long been in a decline.

In January 1943 the only discovery was an extension to the Rio Vista natural gas-field, although wildcatting has been up to the average in numbers.

Undrilled locations in proved territory are not great in number. G. D. H.

526. Petroleum Exploration and Development in Wartime. E. de Golyer. *Oil Gas J.*, 25.2.43, **41** (42), 53.—During the last four years the rate of oil discovery has been less than the rate of oil production in the U.S.A. The need for increased oil production can best be met by the discovery of new pools. During the past four years there has been an excess capacity to produce, and this is still the case, but transport problems will have to be solved before full use can be made of the productive capacity. Even then, however, this will not meet demands.

The numbers of wildcat wells drilled and of geophysical and core-drill crews in operation show the exploratory effort to be at an all-time high, but the results have not been good enough. There is nothing in the past history of the U.S. oil industry to suggest that the annual discovery of about 1,500,000,000 brl. of oil (the present yearly consumption) can be continued indefinitely.

The P.A.W. has recommended the drilling of 4500 wildcats in 1943, compared with 3045 completed in 1942. G. D. H.

527. Drilling Restrictions Bottle Up Large Reserve at Wilmington. L. P. Stockman. *Oil Gas J.*, 25.2.43, **41** (42), 104.—Wilmington has a 50,000,000-brl. reserve in the Tar sand, and this could do much to ease the Californian supply situation, but the refusal to allow exceptions to M-68 as amended renders this reserve unavailable. The present formula penalizes fields with several distinct and separate oil-zones, and while preventing development of the comparatively shallow Tar zone, allows deep drilling elsewhere. There is a P.A.W. objection to drilling two wells on any ten acres, although each well produces from a different sand and a separate zone. P.A.W. recommended that operators should kill wells producing from the Terminal and perforate opposite the Tar and Ranger zones.

Wilmington has five fault-blocks which behave independently. The 200-ft. Tar zone is not as prolific as the Terminal and Ford zones. Its base is 2400–2800 ft. deep, and the oil is highly viscous. Considering the field as a whole, the average acreage per well is about 3½ for all zones. It is believed that the effective drainage area of a Wilmington well is less than 3 acres.

If the desired number of wells were completed, it is estimated that the Tar zone would give about 3,250,000 brl. in its first year, 2,400,000 in the second year, and 10,500,000 brl. in the first five-year period. The 81 proposed wells would require relatively moderate amounts of equipment.

There are about 1600 proved undeveloped acres of Tar zone production at Wilmington, 800 acres being in the Terminal section. In the highest part of the Terminal section there are 7 separate oil-zones—Tar, upper and lower Ranger (Pliocene), upper and lower Terminal, Union Pacific and Ford (Miocene). The Ford zone has not been fully developed. The Tar zone has only 2 wells, both having shown substantial production under natural flow. The Union Pacific zone, a comparatively recent discovery, may be limited to the structurally high positions. The Ford zone has a large crude oil reserve.

Only 7 fields in California show a more attractive steel factor than Wilmington on a barrel/ton basis. G. D. H.

528. Revisions Account for Higher A.P.I. Reserves. Anon. *Oil Gas J.*, 4.3.43, **41** (43), 34.—According to the A.P.I. during 1942, 1,878,976,000 brl. of new oil were found in U.S.A., 493,497,000 brl. more than the 1942 production. Hence the known underground reserves on 31st December, 1942, were estimated to be 20,082,793,000 brl. Most of the new oil was added by upward revision of proved reserves in fields found prior to 1942. The amount provided by this revision was 1,618,925,000 brl.

The reserve estimates do not reflect the availability or the rate at which these reserves can be produced, and the present known oil can be recovered only over a period of many years and at gradually declining rates.

A table gives the estimated proved reserves in the U.S.A. by States for 31st December, 1942, and 31st December, 1941, together with the 1942 production and the new reserves (discoveries, extensions and revisions) added in 1942. G. D. H.

529. Reserve Estimates. Anon. *Oil Gas J.*, 4.3.43, **41** (43), 69.—The bases of the A.P.I., P.A.W., and *Oil and Gas Journal* reserve estimates differ slightly. The total proven reserves as of 1st January, 1943, are given as 20,082,793,000 brl. by the A.P.I., and as 20,675,899,000 brl. by the *Oil and Gas Journal*, a difference of less than 3%. A year before the corresponding figures were 19,589,296,000 brl. and 20,299,543,000 brl., a difference of 3·5%.

Every year estimates of reserves are revised, and this revision is generally upward in the States and invariably upward for the national total. The revision indicates conservatism in the original estimates as well as technical improvements in production

methods which increase recoveries where applied. But this revision does not imply much, if any, increase in the oil immediately recoverable. It merely means that the life of the fields has been extended, and the additional oil tends to be that which will be produced later under relatively high cost. If the demand becomes greater than the supply available under present methods, it is necessary to over-produce the fields, and this will necessitate another revision of reserve estimates, which will be downward rather than upward.

According to the *Oil and Gas Journal* estimates revisions added 919,496,000 brl. during 1942, extensions 518,580,000 brl., and new fields and new pays 322,808,000 brl.

As regards individual States the A.P.I. and *Oil and Gas Journal* estimates differ considerably in some cases, possibly because the A.P.I. estimates are made by different committees whose definition of the word "proven" may vary. The A.P.I. estimate of the reserves added by discoveries in 1942 is 260,051,000 brl., and covers new fields only. It is therefore much less than the 322,808,000 brl. given by the *Oil and Gas Journal* estimate which includes new sands in old pools. (A table shows the A.P.I. and *Oil and Gas Journal* estimates of discoveries in 1942 by States.) G. D. H.

530.* Drilling Shifting to Less Prolific Areas. Anon. *Oil Wkly*, 8.3.43, **109** (1), 10.—Scarcity of critical materials and a probable increase in petroleum requirements makes it essential for the oil industry to accomplish more with less and less equipment. It is therefore necessary to concentrate drilling at points where the maximum amount of oil can be obtained by the expenditure of a given amount of steel, but this concentration has not taken place, and, without exception, every one of the prolific producing States completed fewer wells in 1942 than in 1941. On the other hand, drilling in the Eastern area has been maintained at pre-war levels. The percentage of the total U.S. completions in the Eastern non-prolific area was 23·6% in 1941 and 32·6% in 1942, whereas in the South-western group of States the percentage was 39·7% in 1941 and 31·9% in 1942.

Transportation considerations have favoured the drilling in the non-prolific Eastern States rather than in the prolific South-western States. Also the interruption of secondary recovery work in the Eastern States might cause a loss of considerable reserves. But the improvement of transportation facilities will make it more satisfactory to draw oil from the South-western States.

A table gives by States and areas the numbers of wells drilled in 1941 and 1942, together with the numbers likely to be drilled in 1943. G. D. H.

531.* More Oil Found than Produced Says A.P.I. Anon. *Oil Wkly*, 8.3.43, **109** (1), 11.—According to the A.P.I. Committee on Petroleum Reserves, 1,878,976,000 brl. of oil were found in the U.S.A. in 1942, 493,497,000 brl. more than the production. This raised the underground reserve estimate to 20,082,793,000 brl.

Of four separate estimates made on 1942 exploratory efforts, the A.P.I. is the only one to report that more crude was found than produced. However, even this estimate shows the declining discovery rate of the last six years, and does not make clear whether the reserves will be great enough to allow increases in production without the waste which would follow any prolonged production at greater than the optimum rate.

To-day's known oil can be recovered only over a period of years and at gradually declining rates. Most of the new oil the A.P.I. credited to 1942 reserve additions was through upward revision of reserve estimates for fields found prior to 1942, and this amounted to 1,618,925,000 brl. This large upward revision is the result of conservative estimates being made for new fields with the full realization that they may have to be revised in the light of more development.

Most of the new oil found during the year was in Texas, where 1,053,547,000 brl. was located according to the A.P.I., and this was more than twice its 1942 production of 483,371,000 brl.

Tables give the A.P.I. estimates of proved reserves in the U.S.A. by States for the beginning and end of 1942, together with the 1942 production. There is also a comparison of the A.P.I. and P.A.W. estimates of new reserve discoveries in 1942, the former being for new fields and the latter for new fields and new horizons. Summaries are presented for the years 1937–42 inclusive, of the A.P.I. estimates of proved

reserves at the end of the year, production during the year, reserve additions due to new fields, additions due to extensions and revisions, with similar data for 1942 and 1941 given by states. G. D. H.

532.* February Drilling Declines to Lowest Point in Years. Anon. *Oil Wkly*, 8.3.43, **109** (1), 34.—In January the completions averaged 346 per week, but in February the average was only 304 per week. In February 1942 the completions averaged 508 per week. 2600 wells were completed in the first two months of 1943, against 4352 in the same period of last year. During 1943 there has been more drilling in Colorado, Kentucky, Montana, and Wyoming than in 1942. Drilling declines greater than the average have taken place in Texas, Louisiana, Mississippi, Indiana, and Michigan.

A table gives by States and districts the classified well completions in February 1943, the cumulative completions for January 1943 and February 1942, and details of the rigs in operation on 1st March, 1943. G. D. H.

533.* Alberta Sets High Production Record in 1942. Anon. *Oil Wkly*, 8.3.43, **109** (1), 35.—The total Alberta oil production in 1942 was 10,143,270 brl., compared with the previous record yield of 9,908,555 brl. in 1941. The average daily yield in 1942 was 27,790 brl. Turner Valley provided 10,003,935 brl. of the total, and this was made up of 9,681,719 brl. of crude and 322,216 brl. of natural gasoline processed from tail gas in the four Turner Valley absorption plants. G. D. H.

534.* Russian Oil Situation Described as "Optimistic." Anon. *Oil Wkly*, 8.3.43, **109** (1), 35.—The winter drive of the Russians has opened the Volga river again for movement of oil by the Russians. According to Zavoico, the Russian oil production, exclusive of Sakhalin, was 238,000,000 brl. in 1941 and 223,000,000 brl. in 1942, but it will probably fall to 195,000,000 brl. in 1943. Sakhalin was credited with 3,285,000 brl. in 1941, and 4,500,000 brl. in 1942, with a similar amount likely in 1943. The Baku area produced 172,645,000 brl. of oil in 1941 and 150,000,000 brl. in 1942. An output of 127,750,000 brl. is estimated for 1943. The Ural-Volga region gave 27,375,000 brl. in 1941 and 42,500,000 brl. in 1942, with 45,625,000 brl. estimated for 1943. G. D. H.

535. Geologic Background of Oil Production in the Illinois Basin. B. F. Hake. *Oil Gas J.*, 11.3.43, **41** (44), 82.—The Eastern Interior (Illinois) Coal Basin of South Illinois and Western Indiana and Kentucky has been submerged and re-elevated repeatedly, the sediments deposited in any one geological episode being relatively thin. Not all parts of the basin behaved identically, and the complex differential movements have influenced the distribution, character, and structural attitude of the strata.

The Ordovician is believed to be the oldest formation in the Illinois basin with potential oil production, and these beds lie 7000–9500 ft. deep in the centre of the basin. The Knox dolomite and the St. Peter have given little oil in Illinois, and the same is true of the Trenton, which has, however, shown better prospects recently. Marine limestones (500 ft.) formed in the Silurian, but they have not given oil occurrences of commercial importance. Further limestones (700 ft.) were formed in the Devonian, which has provided 5% of Illinois' oil and eight important fields, some with very prolific wells. There was elevation towards the end of the Devonian, and in the Lower Mississippian about 1400 ft. of sediments, mainly limestones, were laid down. These have yielded 15% of Illinois' oil, the McClosky with its rapidly declining wells being the most important horizon. In late Mississippian (Chester) times 1200 ft. of sands and muds were deposited, and these variable beds have provided many small fields, the oil possibly having been formed in the Chester shales. The Chester (chiefly Aux Vases, Benoist, Paint Creek, and Cypress) sands have provided 55% of the Illinois oil.

There was uplift and erosion early in the Pennsylvanian, most of the structures in the older beds then approximating to their present form. 2000 ft. of ill-sorted and variable detritus were deposited during Pennsylvanian time, much of it in embayments, lagoons, swamps, deltas, or flood plains. Oil is abundant in the Pennsylvanian

of the older fields of Eastern Illinois, and it has probably come from the eroded Chester. The Pennsylvanian wells commonly have little gas and do not flow as a rule. The sands are lenticular, and wells continue to produce for many years at a low rate.

There has been little deformation in the Illinois Basin since the Pennsylvanian, and if younger beds were laid down they have been entirely eroded.

Where sedimentation was slow, oil-fields are generally less prolific than where sedimentation was rapid, for there was greater opportunity for destruction of the organic matter before burial. Illinois seems to have had slow sedimentation except in the Chester, which has given more oil than all the other formations in the basin combined. Extensive, uniform strata permit regional migration and provide large fields as at Salem and Louden, whereas heterogeneity gives mainly small fields (Central and Eastern Illinois) or extensive composite fields. Even on the La Salle anticline, the largest anticline in Illinois, structure is only partly responsible for the shapes and sizes of the oil accumulations. G. D. H.

536.* **The Oil-fields of Western Canada.** C. M. Hunter. *J. Inst. Petrol.*, March 1943, **29** (23), 75–88.—The paper deals with the geology, development, and certain details of drilling, completion, and production practices of the Canadian oil-fields in general and of Turner Valley in particular. Special difficulties encountered by geologists and drilling engineers in the foothills are mentioned. Athabasca tar sands are also discussed. The paper is followed by a discussion. A. H. N.

537.* **Wildcatting and Oil Reserves.** F. H. Lahee. *World Petrol.*, March 1943, **14** (3), 30.—A table gives reserve data for the group of eleven States—Arkansas, California, Illinois, Indiana, Kansas, Louisiana, Michigan, Mississippi, New Mexico, Oklahoma, and Texas. The data are given annually for the years 1937–1943 inclusive, as far as possible, and include the proved reserves on 1st January of each year, the net change in proved reserves since the beginning of the previous year, the total new reserves added in the year, the production during the year, the number of years' supply in terms of production during the previous year, the total number of wildcats drilled and the wildcat footage, the proved reserves found per wildcat and per foot of wildcat drilling. The same data are also set out graphically. While the number of wildcats drilled and the amount of wildcat footage have been rising in recent years, the reserves found per wildcat or per foot of wildcat drilling have been falling. G. D. H.

Geophysics.

538.* **Micromagnetics : a New Quantitative Geophysical Method.** W. P. Jenny. *Oil Wkly*, 8.2.43, **108** (10), 21.—Some sedimentary strata are strongly magnetic, some weakly magnetic, and some non-magnetic. It may safely be assumed that the magnetic material in the sediments will be uniformly distributed within limited regions, and that changes in distribution will be regional rather than local. It is likely that the shallowest structurally-disturbed magnetic bed is the source of the observed local anomalies. And structurally undisturbed shallower magnetic beds will add a constant, or, through dip, thickening, etc., a regionally increasing or decreasing effect. Over large areas on the Gulf Coast experience shows that 1 gamma corresponds to 20–30 ft. of local structure in the Heterostegina or Wilcox. It is therefore necessary to survey the area with an accuracy of $\pm$ 1 gamma for each station.

A hypothetical example is discussed in order to explain the new micromagnetic interpretative procedure. By plotting a series of parallel micromagnetic profiles a general course is observed which represents the regional magnetic dip along the profiles. Assuming that the regional magnetic dips of the various profiles lie in a plane, regional magnetic isogams may be drawn, and the positive or negative difference between the station values and the regional intensities gives the local magnetic anomaly at each station. Allowing 20 ft. local anomaly per gamma and connecting the points of equal footage leads to a relative structural contour map. If the general regional dip of the beds in the area is known, combination with the relative structural contour map provides a sub-sea structural contour map. G. D. H.

539. **The Use of Electrode Spacing in Well Logging.** R. H. Zinszer. *Petrol. Tech.*, March 1943, A.I.M.M.E. Tech. Pub. No. 1590, 1–10.—The quantitative analysis of

electric logs must take cognisance of sand thickness, permeability, interstitial water saturation and salinity, mud resistivity, formation temperature, etc.

A series of sands ranging from 1 ft. to 30 ft. in thickness have been studied in California in a well which was cored continuously throughout the section investigated. Circulation of mud was continued for four hours after the last core was taken, in order to ensure a uniform conditioning of the mud. Electrical logging runs were then made with electrode spacings ranging from 5 in. to 89 in. The mud and formation temperatures were measured, and the salinity of the interstitial water was assumed to be the same as that of the water produced. The different electrode spacings provided formation resistivities for different "depths of penetration." On plotting resistivity against "depth of penetration," the resistivity, starting from the resistivity of the mud, increased with "depth of penetration" to a maximum, and then declined for greater penetrations. The increase is due to fresh-water infiltration from the mud. In the case of thin shells the final decrease in resistivity is partly caused by the low resistivity of the adjacent shales. For sands of the same permeability, the maximum occurs at smaller penetrations the thinner the sand. The position of the maximum does not imply smaller penetration of infiltrating fluid in the thin sands, since the shift in resistivity maximum is largely due to the effects of the low resistivity of adjacent shales, which becomes noticeable for thin sands. The limits of infiltration effects can be observed more clearly for thick sands.

There is an approximately linear relationship between log.-resistivity and log.-sand thickness for thicknesses up to about 7 ft., the resistivity being higher the higher the permeability.

A series of theoretical curves were derived for the relationship between resistivity and water saturation at different salinities, and a curve has been constructed to give the relationship between sand thickness and a thickness factor which, when multiplied by the measured resistivity, gives the true sand resistivity. The individual water saturations were obtained by inserting the corrected resistivity on the appropriate salinity curve. Eight sands were examined, and after weighting the saturations for thickness and permeability, the saturation calculated was found to be greater than the critical saturation, suggesting that the sands would produce some water initially.

G. D. H.

540.* Geochemistry's Place in Future Exploration. R. O. Smith. *World Petrol.*, March 1943, **14** (3), 45.—The Russians were the first to employ geochemistry in prospecting for oil. They argued that the gases associated with oil would probably escape to the earth's surface, and perhaps be detectable in the soil, and considered that the ratio of ethane to methane is important.

Non-commercial accumulations of oil can give geochemical indications which are misleading, and these are frequently in limestones near source-beds. A further source of difficulty is the shift of structure with depth or the non-vertical movement of the escaping hydrocarbons. Some hydrocarbons are believed to rise more vertically than others, thus providing a means of estimating the depth of oil deposits. However, exceptions to the normal drift behaviour are not uncommon.

It is possible to determine whether the oil indications come from sand or from limestone beds.

Geochemistry has had notable successes as well as failures. It may be possible later to outline a field precisely, but at present the main requirement is that it should locate oil. Where adequate surveys were made, four out of ten wells located by geochemistry have been successful.

It is possible that three times as much oil is associated with stratigraphic traps as with anticlines, and while the latter are fairly easily found by physical and geological methods, there is no certain and non-laborious method of locating the former. Geochemistry is of value in discovering stratigraphic traps, and in combination with geology and geophysics led to the opening of the Santa Barbara field of Venezuela. It may be expected to be used as an exploratory tool on new prospects, as an outlining agent, and as a means of selecting favourable and unfavourable strata for drilling.

G. D. H.

541.* Accelerated Discovery Through Geophysics. L. I. Freeman. *World Petrol.*, March 1943, **14** (3), 48.—The desire to discover oil directly has led to much research,

but has not so far developed any quick and infallible method of locating hidden oil accumulations. New oil-finds in the near future are likely to be made only by the application of every possible method and all knowledge to the areas under examination.

The amount of materials allotted is insufficient to maintain the normal number of geophysical parties in the field, and the operating personnel numbers have fallen below minimum requirements, while labour laws have restricted working time. In view of these difficulties more efficient geophysical exploration requires: (1) The employment of the geophysical unit most suited to a given area, with men in charge who are experienced in that particular area. Competitive exploration should be avoided. (2) The reduction of the time between discovery and testing of a structure, with power to make decisions, to appraise and assemble leases, and to conduct exploratory drilling vested in district offices without reference to headquarters. (3) The pooling of information within each area. This might save many dry holes drilled at great expense. Adoption of the above suggestions might result in accelerated discovery. G. D. H.

542. Amplified Curves Widen Value of Electric Logs. L. R. Dawson. *Oil Wkly*, 1.3.43, **108** (13), 26.—A high percentage of connate water and/or an abundance of volcanic ash in a formation will have a damping effect on the third and fourth curves of electric logs, and under normal sensitivities they will show very little definition of fluid content. This makes it difficult to determine oil–water contacts, and often even the presence of oil and/or gas is not apparent in the normal sensitivity run.

In South-west Texas these conditions are common, and an amplified third curve brings out features which are not distinguishable on the normal run. An example is given, with the normal and amplified third curves, and the amplified third curve clearly shows the fluid content. The amplified sections require only a few minutes' extra time to secure.

In some areas, *e.g.* the Wilcox trend, invasion of the sands by drilling fluid has complicated the interpretation of electrical logs. The third curve is comparatively useless, as it has a high intensity in nearly all the sands. The fourth curve must be used for fluid-content determination, but even its deep penetration is affected over a period of time in drilling ahead. A fifth curve of even greater penetration is used to facilitate interpretation by getting beyond the range of formation invasion, and the fourth and fifth curves together are used as a basis for the interpretation of fluid content. The third curve can often be employed if certain procedure is followed: (1) Electrical logs are run every seven to ten days when drilling in the Wilcox sand; (2) overlap sections are run each time a new run is made, and the changes in the curves are checked; (3) the saline content of the drilling mud is increased just prior to entering the Wilcox to reduce diffusion or ionization effects. G. D. H.

Drilling.

543.* Proper Installation and Care Stretch V-Belt Life. E. Sterrett. *Oil Wkly*, 18.1.43, **108** (7), 10–16.—Detailed instructions and hints on installing and maintaining V-belts on oil-field equipment are given, together with illustrations. The following is a summary of the instructions given: (1) Do not allow oil, grease, or gasoline to come in contact with belts. (2) Avoid exposing belts to sunlight and excessively hot or cold weather. (3) Insure proper-sized pulleys for drive. Too small pulleys shorten belt life. (4) Provide take-up facilities. The initial setting should allow $\frac{1}{2}$ motion towards driven unit, $\frac{1}{2}$ for belt take-up. (5) Avoid heavy overloads. Add one or more belts to initial set-up if loading is increased. (6) Don't leave tools or other objects where they may fall into and damage belts. (7) Avoid abrasion against nearby objects. Slight shaft misalignment may set up destructive side-sway and intermittent contact. (8) Do not force belt on to sheave with tools of any kind. Slack off on take-up and lay belt in grooves. (9) Work belts around grooves until all the slack is on one side of the drive, and then tighten take-up to secure desired tension. (10) Use sufficient number of correct-sized belts to handle maximum load. Check to insure sheaves being over accepted minimum diameters for belt size and type used. (11) Design new drives to call for standard size and length of V-belt with adequate adjustment for stretch. (12) Prevent V-belts from bottoming in grooves. Bottom friction sets up destructive heat, greatly shortening belt life. (13) Do not use belt

dressing. If belt slips, clean with rag moistened with high-test gasoline (clear, not ethyl) and tighten drive slightly. (14) See that all sheave grooves are clean, free from burrs or nicks and excessive wear. Replace sheaves and check alignment periodically. (15) On failure of first belt in drive, renew throughout. Save other worn belts for replacements, as second set shows signs of excessive wear. (16) Before starting drive first time, check (*a*) pulley alignment; (*b*) bearings for oil; (*c*) drive clearances. Adjust so that at full load only slight bow or sag appears on slack side. (17) Vertical drives, extremely short-centre installations, and drives for pulsating loads where no flywheel can smooth peaks must be operated more tightly than others. (18) Check for odour of hot rubber. If this persists after first few minutes of operation, drive should be checked throughout for cause and difficulty corrected. (19) Belt should be stored uncoiled; preferably hung over forms of minimum pulley diameter or larger, and in a cool, dark, and dry place. Do not hang spare belts on nails or loop over pipes or single board supports, and do not tie together tightly with cord or wire. (20) Protect against acid fumes, smoke, and dust. A. H. N.

544.* Safeguarding and Extending Cordage Service Life. E. Sterrett. *Oil Wkly*, 25.1.43, **108** (8), 11–15.—Prolongation of rope life begins with its receipt from the warehouse or distributor. If delivered in the sacking-covered coil, the unit should be carried flat, not stood on edge while being trucked to destination. It should rest flat on the truck bed or platform, and should neither lie atop tools, wrenches and pipe, nor below any of these. During transfer it should be kept dry or, if soaked by rain while in transit, the coil should be stripped of its sacking cover and flaked down with end turns not less than outside diameter of initial coil until the fibres have thoroughly dried. Inspection of the inside of the rope frequently demonstrates that the outside may appear dry while the interior still retains considerable water. Twisting the rope between the hands to open a space between adjoining strands permits examination of the interior of the rope. Similarly, thrusting a marlinspike into a rope to open a space permits like examination of a strand. Wet fibres can be recognized by their darker colour, and also by a tendency to cling together, rather than to present an array of fine bristles or fibres sticking out at all angles to the laid material.

Drying of a rope, whether new or well worn, should be carefully done if maximum rope life is to be attained. The rope preferably should be dried in the sun, either laid flat on a smooth, clean surface, or strung back and forth between a pair of horizontal arms on posts so set that the span of rope is not carried over steam pipes, water, or loose dirt or dust. A wet rope, no matter how soon it is again to be needed, should never be wrapped round a fired rig boiler—even if the latter be lagged—the coils thrown across it, or even suspended between two adjoining boilers. The excessive heat to which the outside fibres are exposed will drive off the lubricant which is built into the rope, and will tend to impart a permanent fix or set to the fibres, impairing the ability of the rope to distribute stress equally throughout its cross-section. Storing of rope in an excessively dry place will also result in rapid deterioration. Details are given of the method of storing ropes so that adequate "breathing" is maintained. Hints are also given on correct use of rope. Rope, lubricated at the walk, has built into it ample supply to last its normal working life. It should not be lubricated with any of the mineral or animal oils used around machinery, nor, if accidentally coated with these or crude petroleum, should it be soaked in gasoline to clean. Linseed oil and other quick-drying water-repellants are also detrimental to the life and proper functioning of the outer fibres of a rope, and should not be used.

Rope should never be exposed to acid fumes or hot exhaust gases. Gases such as those emanating from sour crudes can reduce rope life by half through the effect of the fumes on the fibres; alkali dust is equally bad for ropes, in addition to the abrasive action of the particles. To obtain long rope life: run slowly; load gradually; keep dry; splice instead of tie for permanent junction; reverse ends frequently; cut and splice at worn spots. A. H. N.

545.* Drilling Curb Hits Rotary Rigs Harder Than Cable Tools. Anon. *Oil Wkly*, 1.2.43, **108** (9), 86.—Primarily reflection on the fact that restrictions on drilling more severely affected development in fields of the South-west, Middle West, and California than work in the Appalachian region, there was a sub-normal proportion of rotary rigs in operation in the United States on 1st January, 1943 (53% of the total), and a

greater than normal ratio of cable-tool operations (47%). A table gives data on types of rigs doing different jobs by states for the United States on 1st January, 1943.
A. H. N.

546. Application of Direct Motor Drive With Use of Electric Motor. N. Williams. *Oil Gas J.*, 4.2.43, **41** (39), 31.—Rotating entails considerably lighter power loads than hoisting, so when the rotary table is driven by the hoisting engine or motor there is an excess of power for that purpose. In an independent drive for the rotary a smaller engine or motor can be used, making possible substantial economies in power and fuel costs. At the same time, with the hoisting engine or motor operated only for that purpose, wear and tear on this equipment and on the line or jack-shafts, through which the rotary table would be driven, are reduced, saving in maintenance and replacement costs.

Electric motors approach the steam engine in smoothness of performance and control. However, in direct drives their ability to absorb shock loads, such as are incurred in rotary-table operation when increasing and decreasing speeds, has been dependent on the provision of a suitable flexible coupling or connection in the drive-shaft between the prime mover and the load. In the absence of adaptable couplings for that purpose, operation of motors also has usually called for installation of reduction-gear units or other means of indirect drive.

Problems which have stood in the way of employment of electric motors in direct rotary drives apparently have been overcome, however, in an installation that has been made on a large diesel-electric rig operated by a large major company on the Louisiana Gulf Coast. The installation, the first of its kind, has now been in operation several months and has proved unusually effective, meeting all requisites for wide flexibility and simplicity in speed control and smooth performance. The unit is so small and compact that it occupies less space on the derrick floor than a steam-powered prime mover, and is so placed that it presents practically no obstruction. The rig is a drilling barge assembly used in maritime operations in the marsh and water areas along the coast. Diesel engines driving the generators supplying the electricity are capable of delivering 1000 h.p. The power plant is housed on a separate submersible-type barge with cable extensions to the main drilling barge. The draw-works, three mud-pumps, wire-line coring unit, and various auxiliary units, are all driven by independent motors as prime movers. All equipment is of the large and heavy-duty type and suitable for Gulf Coast deep drilling. Details are given of the coupling used, the type of installation adopted, and of the electric circuit employed.
A. H. N.

547.* Proper Care Can Double Service Life of Rubber Hose. E. Sterrett. *Oil Wkly*, 8.2.43, **108** (10), 11–14.—Of all the oil-industry equipment involving rubber in its construction, rubber hose is least likely to be rendered unserviceable solely through the loads placed on it by the service for which it is designed. Experts estimate that not one hose in ten actually wears out through carrying fluids, including gases and steam. External heat, light, acids and gases, abuse, and unnecessary abrasion shorten the life of most units, and the greatest factor in hose deterioration is abuse. The amount of rubber in a rubber-lined cotton fire hose is relatively slight, while the percentage of the same material in a rotary hose may be high, but in either instance failure of the sealing material—the rubber—renders the hose unfit for further service. The paper deals with various abuses of hose and gives hints on its proper maintenance.

The following is a summary of how to prolong hose life: Handle with care. Avoid kinking when uncoiling. Let hose untwist when pulling from coil. Avoid stretching hose—when filled to working pressure it tends to shorten and fastening both ends rigidly when fully extended imposes severe strains on fabric. Do not walk on hose, nor roll heavy objects over even a wire-reinforced hose. If once deformed, do not attempt to hammer a flattened hose back to round again. If pressure does not help reshape the deformed section, cut out damaged length and splice with rigid coupling Avoid sharp bends and kinks. Hose is designed to carry equal stresses all around its circumference. In a kink the outside is overloaded, the crimp carries no pressure. Hose is built with a factor of safety of four. Operating under a lower factor decreases hose life, due to excessive fatigue. Do not expect a hose to span wide gaps and carry load. A plank spanning the gap will support the hose and prevent overstressing. Be

sure the hose is used in the service for which it was built. Suction hose is not built to withstand interior pressure, nor pressure hose to resist collapse, nor should steam be carried in water hose. Hose not in use should be carefully drained, then coiled and stored flat in a cool, dark place away from sunlight, oils, acid, and fumes. A. H. N.

548. Value of Directional Drilling to Straighten Hole Shown by Wood County Discovery. H. F. Simons. *Oil Gas J.*, 11.2.43, **41** (40), 41–42.—The paper describes the use of directional drilling to straighten a well in a particular instance. The drilling of the well demonstrated the application of the technique. In this case, directional drilling was tried after attempts to shoulder-up failed, and an excellent comparison of the techniques was afforded. It also showed that in areas commonly known for ease of drilling and where all the necessary precautions are taken, a hole may deviate from the vertical. Also, while the formations are such as to make the hole drift from the vertical, it does not necessarily follow that the straightening of the hole is easily accomplished.

It is believed that the condition of the mud affected the deviation of the hole to a great extent. Considerable difficulty was experienced in getting an adequate water supply for the drilling of the well, and sufficient water was not available to control the viscosity of the mud properly while drilling the interval from 2600 to 3700 ft. The mud became practically jelly-like with a viscosity of 100 seconds A.P.I. for 500 c.c. out. Cuttings were not removed properly from the bit, the thick mud reduced the rate of penetration, and the drillers probably increased the weight beyond what they would have used had the mud been normal. Using a mud weighing 9·5 lb./gall. with a viscosity of around 23 secs. A.P.I. for 500 c.c. and slightly less weight, this section could probably be drilled without the hole deviating appreciably. The hole deviated to a slightly greater value than 4°. The time required to bring the hole back by directional drilling was 11 tours and during this time 273 ft. of new hole was made. This can be contrasted with the 26 tours spent in attempting to straighten the hole by shouldering up and by the use of the cement plug. During this time only 187 ft. of hole was made, and in the shale being drilled this should have taken about 1¼ tours. The net time comparison in tours could be 23¾ for the shouldering-up method which produced no results to eight tours for the whipstocking method which did produce the desired results. The method also compares favourably with the shouldering-up method on a cost basis. A. H. N.

549. Response of Gulf Coast Drilling Mud to Chemicals, Temperature and Heat Treatment. G. Fancher and R. L. Whiting. *Petrol. Tech.*, March 1943, A.I.M.M.E. Tech. Pub. No. 1589, 1–15.—The experimental work was carried out on a typical drilling mud from the Hastings field of Texas. The mud contained only 8% (dry weight) of material of colloidal dimensions, which is largely illite. The treatment of the mud was carefully standardized, and viscosities were measured in a Stormer viscometer, and gel strength in a Stormer viscometer modified by the addition of a chainomatic weight device. Successive quantities of tenth-molar and molar solutions of various phosphates were added to samples of the mud, and the viscosities, and in some cases the *p*H and filtration rate, were measured. The effects of dilution were examined. Dilution lowered the viscosity and gel strength while increasing the filtration rate, and the polyphosphates as a group caused greater viscosity reduction than the orthophosphates. The number of mols. of polyphosphate required for a maximum reduction in the viscosity of the mud caused solely by surface adsorption of the chemical was independent of the particular polyphosphate used. The viscosity-reduction curve obtained on dilution is seemingly a function of the type and chemical nature of the aqueous solution added, the viscosity at the time of chemical treatment, the original stability of the suspension, and the mineral composition of the mud.

Sodium acid pyrophosphate and sodium tripolyphosphate were more efficient than other complex polyphosphates for chemical treatment, and mud treated with either of these two compounds showed maximum reduction in viscosity and minimum filtration rates at low concentrations, while the treated muds were virtually unaffected by heat treatment.

Heating causes permanent changes in the rheological properties of a mud, the changes depending on the time of heating up to a certain maximum time. The viscosity of a mud at an elevated temperature depends on the relative value of the viscosity-

temperature variation of water, and the effect of temperature on the dispersed clay in the mud.

Generally, the minimum filtration rates for chemically treated muds were obtained at points of maximum reduction in viscosity. G. D. H.

Production.

550. Volumetric and Viscosity Steadies of Gas and Oil from the Santa Maria Valley Field. R. H. Olds, B. H. Sage and W. N. Lacey. *Petrol. Tech.*, March 1943, A.I.M.M.E. Tech. Pub. No. 1588, 1–11.—The specific volumes of the trap liquid and of four mixtures of this with the co-existing trap gas from a surface separator in the Santa Maria Valley field, were determined at 100°, 190°, and 250° F., and at pressures up to 4000 lb./in.². The viscosity of three mixtures of the trap samples was measured at 100°, 190°, and 250° F. for pressures up to 5000 lb./in.². The gas–oil ratio of the four mixtures ranged from 111 to 813 cu. ft./brl.

Studies of the volumetric behaviour of the trap liquid showed the specific volume of the bubble-point liquid to increase at a diminishing rate with increase in bubble-point pressure. For the sample with a gas–oil ratio of 111 cu. ft./brl. the curvature of the bubble-point locus is opposite to that for the trap sample. The bubble-point pressure increases almost linearly with the gas–oil ratio for a given temperature, the rate of increase being higher the higher the temperature. There is an almost linear relationship between formation volume and gas–oil ratio throughout the heterogeneous region covered by this experimental work.

For the trap liquid, the viscosity is a minimum at the bubble point, and log.-viscosity increases roughly linearly with the pressure, and is lower the higher the gas-oil ratio.

Tables give the composition and properties of the trap samples, the composition of the experimentally studied mixtures, and the volumetric behaviour of these mixtures; the properties of the bubble-point liquid, and the viscosity of the experimentally-studied mixtures and of the bubble-point liquid. Much data are presented in graphical form. G. D. H.

551.* Proper Counterbalancing—An Equipment Conservation Measure. E. N. Kemler. *Oil Wkly*, 11.1.43, **108** (6), 9–12.—The paper deals with the elements of counterbalancing wells and treats the problem in a very simple manner. When new equipment is installed a smaller size of unit can frequently be used if the engineer or manufacturer can be assured that the well will be kept properly counterbalanced and, in the interests of conservation, operators of equipment should see that this is done. There are several possible means of checking whether or not a well is properly counterbalanced. D. O. Barrett has outlined one simple procedure which can be used by any field man. ("Proceedings, 21st Annual Meeting, A.P.I."—1940, *Bulletin*, 226, p. 200.) This method uses the clutch, which is a torque or power transmitting device, to check the torque or power being transmitted. The procedure in this method is as follows: 1. Set the throttle on the engine at a fixed position. 2. Release the clutch slowly to the point where it will pull the peak load. A further release will result in the clutch slipping equally on the up and down stroke if the well is properly counterbalanced. If it is considerably out of balance, it will slow up and slip on one side and speed up and hold on the other. A little experience with wells in and out of balance will develop a technique in checking of wells. Usually the speed variation in the case of wells out of balance is noticeable and can be used to check the well. When the throttle is not set at a fixed position the time lag of the governor may cause speed fluctuations that might be incorrectly interpreted, so that it is important that the throttle be set before the counterbalance is checked.

Other methods will be discussed in future instalments on this problem.

A. H. N.

552.* Good Judgment Required to Fight Production Corrosion Problems. F. Briggs. *Oil Wkly*, 11.1.43, **108** (6), 13–16.—The problems encountered in corrosion are discussed together with the tests to be made and countermeasures to be taken to minimize corrosion troubles in production. The selection of proper equipment involves the

two items of tubing and rod string. With tubing, the selection is between manufacturing processes rather than chemical or alloy content. However, tubing fabrication such as wrought iron can be specified. Sucker rods, while more involved in alloy content, have been more or less standardized as to type. The field application of zinc to the rods is a process of moulding. The mould should fit around the rod, be approximately 5 ins. in length and contain enough volume to hold between 2 and 5 lb. of zinc. The rod should be prepared for the zinc by cleaning the surface of all scale and then slightly roughing so that a good bond between the rod and the zinc may be obtained. Only pure zinc should be used. Zinc inserts for specially prepared cages are commercially manufactured and may be obtained where the producer does not desire to mould his own zinc protectors.

The inspection of rods and tubing is a technical service rendered by a few specialized companies. Pitted rods can be found and discarded by the field personnel, but a new and intricate device is required to locate the small fatigue cracks prevalent in rods subjected to high loads and corrosive fluids. Inspection of the tubing walls is also an involved process but one that is available in most localities. (A very comprehensive description of these two inspection processes was published in *The Oil Weekly*, March 17, 1941.) Insulated flanges for lines are manufactured commercially. These flanges are installed between the suspected source of the electric currents and the part to be protected, whether it be well or storage tank.

The chemical processes for combating corrosion are of two types: those that tend to change the fluid characteristics from "acidic" to "basic," and those that form a protective sludge coating on the tubing walls and the surface of the rods. The first method is used mainly in closed systems of small dimensions, such as the cooling system of an engine. The sludge coating chemical is sold commercially and usually involves injecting the chemical in the casing at regular intervals. In each case, instructions for the use of these chemicals are provided by the manufacturer.

A. H. N.

553.* Application of Gravel Packing to Unconsolidated Sands. R. Winterburn. *Oil Wkly*, 11.1.43, **108** (6), 17–23.—Both prepacked gravel liners and gravelling by circulation are discussed.

Perforated liners which are prepacked with gravel in the annulus between the liner and a perforated outer sheath before being run into the well have come into general use among small operators at Wilmington. The most important factors affecting the performance of this type of gravel screen are: (1) Selection of proper gravel size. (2) Provision of ample area of perforations in outer sheath. (3) Uniform tight packing of the gravel in order to prevent movement of gravel and possible uncovering of perforations before the liner is landed. (4) Thorough removal of mud and filter cake from the well before placing on production.

Selection of proper gravel size has been the subject of much experimentation, and is covered in a general discussion of the selection of gravel size elsewhere in the article. Perforated outer sheaths used in prepacked liners are generally made of plates punched with $\frac{1}{16}$-inch round holes on $\frac{1}{32}$-inch centres, 60-mesh horizontal slots, or woven steel wire screen. These types have 25% to more than 30% of their surface consisting of perforations and have performed satisfactorily. Outer sheaths resembling conventional slotted liners in per cent. of area perforated have not yielded as high initial rates in comparable wells.

Gravel packing by circulation is then discussed, followed by the principles of flow and sand-carrying capacities of flowing fluids. Experience in Wilmington wells has demonstrated that sand entry is practically eliminated in all cases where the ratio of maximum gravel diameter to the 10-percentile sand-grain diameter is 12 or less. The finest sand encountered in most Wilmington wells has a grain diameter at the 10-percentile point of about 0·015 inch. Gravel sizes used most commonly in prepacked liners are 0·003 to 0·131-inch and 0·131 to 0·187-inch. One manufacturer has standardized on 0·070 to 0·110-inch gravel and one operator has installed a number of liners packed with 0·078 to 0·093-inch gravel. Recently a number of liners have been packed with 0·187 to 0·279-inch gravel. This size is designed to permit the entry of small amounts of sand into the well, with the purpose of minimizing the plugging action which apparently takes place at the outer periphery of the gravel. This practice is discussed.

In gravel-packed wells the most common gravel diameter used is 0·131 to 0·187-inch; some wells have been packed with 0·093 to 0·131-inch gravel, and several of the early jobs used ¼- to ⅜- or ½-inch gravel. Those wells packed with this coarse gravel (more than ¼-inch) have produced sand to some degree but have experienced much less difficulty than the average well with conventional liner.

A. H. N.

554.* Performance of Unconsolidated Sand Wells Using Gravel Packing. R. Winterburn. *Oil Wkly*, 18.1.43, **108** (7), 20.—Graphical data are presented on the performance of gravel-packed wells. In the case of the circulated gravel packs it is noted that the curves show an initial rate of decline which is less than or equal to that of conventional wells. In the later stages the circulated packs show nearly constant or accelerated decline, while in the conventional wells the tendency is for the rate of decline to diminish. Wells with prepacked liners exhibit more rapid initial rate of decline of productive index, decreasing in later stages. Throughout the history available up to now, the rate of decline has remained more rapid than in comparable wells with conventional liners.

In general, it has been observed that wells gravel packed with mud as a circulating fluid have considerable lower initial productive indices than comparable wells with conventional liners. A few wells which were gravel packed with oil as a circulating fluid have apparently exhibited better initial productivity, although data are not available to permit direct comparisons with conventional completions made at the same time.

Experience at Wilmington has demonstrated that: (1) Reduction of production expense, ability to produce at higher rates for several years, and elimination of the risk of sand abrasion and collapse of liners can be attacked through the use of circulated gravel packs and prepacked liners in areas and zones presenting acute sand problems. (2) Where all sand is screened by the gravel pack, plugging at the gravel face may reduce the productivity of the well to uneconomic rates before the producing sands are depleted. (3) There is a possibility of increasing the economic life of wells without necessity of remedial work by use of gravel large enough to permit production of small amounts of sand continuously. However, this practice entails increased operating costs and greater risk of eventual damage to liners.

Possibility of using smaller water strings and still providing ample clearance for washing over and recovery of liners with the same inside diameter in the case of the circulated gravel packs should be considered. This is illustrated by the fact that a 4-inch liner may be washed over through a 7-inch water string, while the same liner prepacked to 5½-inch outside diameter would require an 8⅝-inch water string to permit washing over.

In deciding whether to select gravel designed to screen all sand or to permit small quantities of sand to be produced with the oil, no general rule can be stated. All experience bearing on the particular case under consideration should be reviewed. Those wells in which initial production rates of from 100 to several hundred brls./day are anticipated, and which experience has shown may be expected to have relatively long productive life before declining to uneconomic rates, are in a position to benefit to the greatest extent from the minimum production costs and absence of risk of damage to the liner to be gained by complete exclusion of sand. On the other hand, low-pressure-heavy-oil zones yielding wells of small initial production afford the best opportunity for advantages to be gained from use of coarse gravel to permit some sand entry into the well.

A. H. N.

555.* Degasification of Coal Seams Would Give East Gas Fuel. Anon. *Oil Wkly*, 18.1.43, **108** (7), 33.—The paper presents a brief explanation of methods which can be used to degas coal seams using vertical as well as Ranney's horizontal boreholes. Technical and economical factors are studied in brief.

A. H. N.

556. Efficiency of Bradford Water Floods Can be Greatly Increased. H. M. Ryder. *Oil Gas J.*, 21.1.43, **41** (37), 29.—The principal unnecessary losses of oil have been caused because of: (1) Not utilizing all of the pay-sand. (2) Flooding the sand too slowly to wash out all the available oil. (3) Shooting very open and worthless sand

so heavily that it takes most of the water supplied, leaving an entirely inadequate amount for the pay-sand. (4) Not providing proper back pressure for floods—*i.e.*, one-sided flooding. (6) Packing off pay-sand. (7) Ignoring old water, known or unknown, already in the sand. (8) Unnecessarily trapping oil between floods and the edges of sand layers. The first four items are discussed separately and in some detail; the last four are grouped and discussed together. It is concluded that if Bradford producers are to realize the extra $100,000,000, which they can do, they must flood all the sand at their wells, they must flood it at as nearly the most efficient speed as possible, provide sufficient intake wells, and drill their producing wells into oil instead of into water. This is being done on some properties.

Objections to these conclusions are: (1) Experience is considered to indicate that high pressure causes "by-passing" not found at low pressures. (2) All the available oil is expected to be produced at some time, no matter what plan of development and operation is followed. (3) If a property has not produced satisfactorily, the sand is considered to be the only cause. The method has nothing to do with it. (4) A neighbouring property or the producer's own property has shown a profit with slow flooding, therefore slow flooding is satisfactory. (5) Production over many years is desired as income insurance. Full-speed flooding is considered to water out the sand too rapidly. (6) Full-speed flooding produces most of the oil during the first year. This is considered to result in an unbalanced income and in unnecessarily excessive taxes. These arguments are discussed. A. H. N.

557. Dual Completions in Kansas. N. Williams. *Oil Gas J.*, 21.1.43, **41** (37), 53–54.—Producing horizons concerned in the dual completions in Rice and Barton Counties are the Kansas City–Lansing series as the upper zone and the Arbuckle lime as the lower zone. The former, which is found around 2870 ft., contains from one to three pay-zones with a thickness of from 5 to 15 ft. each. The Arbuckle lime, which is found at slightly under 3200 ft., probably has a thickness of several hundred feet, but generally is not penetrated more than 15–20 ft. Minimum penetration to get production is desired, sometimes not more than a foot or two, because of the danger of water encroachment. For dual completions involving these two formations the practice has been to drill the well first to the top of the Arbuckle dolomite, usually with rotary tools. Then, with the oil-string landed at that point and cemented with enough cement to fill up behind the casing to above the top of the Kansas City-Lansing series, the well is completed in the Arbuckle in the usual manner, and the productivity in that formation established. Then a packing element is installed in the bottom joint of the oil-string, this being run in and set with the string of tubing that is to be used in producing the well. The packer used so far has a flapper valve on the bottom which closes the opening when the tubing, which is run through the opening, is pulled. To test the effectiveness of the packer element in sealing off the Arbuckle, the hole above the packer is bailed dry. With the effectiveness of the seal assured, completion of the well in the Kansas City–Lansing producing zone is undertaken. Completion practice by perforating the casing and acidization is described.

Success of the operation depends largely on the use of an adequate amount of cement in cementing the casing to extend above the top of the upper producing horizon, and on the effectiveness of the seal between the two formations. Should water conditions develop in either formation that cannot be corrected by cementing and that make further production of oil from that zone impossible, the formation can be squeezed and the remaining formation produced alone. All packing elements are made of drillable materials, so that if a failure should occur, packer can be removed and another installation made. A. H. N.

558.* Pressure Maintenance Success is Highly Lenticular Field. J. A. Korafeld. *Oil Wkly*, 25.1.43, **108** (8), 21–22.—The stratigraphy and production history of the Batesville field are given. Success of pressure maintenance at Batesville has been correlated with simultaneous application of efficient production methods in the operation of Bird, Hanley and Sheedy properties. These have insured a greatly-lengthened flowing life, so that currently 75% of the total number of wells on the company's two blocks are still flowing. At one time the entire field produced as much as 1600 brls. of oil/day, largely from flowing wells. These methods include: (1) Use of bottom

hole chokes to control the gas-oil ratio; (2) constant use of small tubing strings; (3) low production rates; (4) elimination of open-flow potential tests for long periods.

The slim tubing strings consist of both ¾-inch and 1-inch. This has remained a constant practice since the field's discovery. The policy of small withdrawals/well and constant production operation as contrasted with large intermittent withdrawals is believed to have created less possible disturbance of the reservoir. Company officials estimate that pressure maintenance will result in doubling of the ultimate per-acre yield within the limits of the two blocks being pressured. A. H. N.

559.* Preventing Oil Traps in Pressured Sands. F. R. Cozzens. *Oil Wkly*, 25.1.43, **108** (8), 28.—One fundamental objective in sand pressuring is to have forces from opposing input wells to meet, as early as possible, in an area of producing wells. An input well with leaky packers, or with packers set too high or too low in the sand, delivers an irregular and feeble pressure, often sufficient to force oil only a short distance from the input zone. Normal pressures from the other inputs, travelling faster and with more strength, reach the producing wells first, and, finding no counter resistance, they move on to trap quantities of oil between the producers and the weak input well. In air or gas pressuring, such traps can generally be released by greatly increasing pressure for a time on the faulty input (after repairs are made), while pressures on nearby inputs are reduced in proportion. In the case of water-flooding, however, this treatment is not practical, because the counter pressure is generally a back flood and the oil cannot be forced through a water-soaked sand.

A well which responds too slowly in comparison with others in the pattern suggests a too tight or restricted sand zone, or some mechanical barrier. Wells which have been in steady production and suddenly begin to fluctuate, and dwindle with no apparent cause, usually indicate weakness in sand pressure, at or very near the producing zones. Wells, building up sudden and abnormal heads of salt water with a receding oil output, often reveal that too high a pressure is being inducted into the low, or water-logged sections of sand. Conflicting, or counter pressures, which meet outside a producing zone may often be detected by an abnormal kickback or a sudden building up of pressure in the input well. These and similar observations are easily noted by keeping daily well records on production and input. Once this practice has become established, prompt adjustments can be made to prevent formation of oil-traps, and the result in more than 80% of the cases is a substantial saving in oil plus a far more effective oil recovery. A. H. N.

560. East Texas' Future Directly Related to Return of Water to Woodbine Sand. Part I. H. F. Simons. *Oil Gas J.*, 28.1.43, **41** (38), 175–178.—Recent production history of the field is reviewed. Graphical representations of production and pressure data are given. Bottom-hole-pressure maps of the East Texas field naturally show the results of producing rates in various sections. Where the well density is high, the pressure is down and all the wells are pumping. In areas where the withdrawal has been more restrained the pressure is up and the wells flow. A water map of the field also reflects the production rate and the rate of encroachment. The water is approaching from three sides—west, south, and north—the east and highest side of the field being practically free from water. By maintaining the bottom-hole pressure above 1000 lb., or even increasing it slightly by controlling the withdrawal, the oil will be flushed out of the sand evenly, the water level will rise gradually, wells will continue to flow until they begin to make water, and the pumping period will be comparatively short. There will be only about 3% oil remaining in the formation after such flushing by natural water drive. The recovery of oil will be increased by some 600,000,000 brls. of oil.

The alternative is to permit the pressure decline to continue, hasten the need for pumping equipment, increase the expense of getting the production, hasten the abandonment of many wells, and decrease the ultimate recovery. Testimony at the recent hearings of the Railroad Commission on the East Texas field showed that the bulk of the wells are abandoned soon after they begin making 300 brls. of water daily. After a well gets to making 100 brl. of water it takes about 10 months for it to get to the point where it can no longer produce its allowable and fall into the marginal class where it can produce less than 20 brl./day. After another 18 months

the well is abandoned, at which time it is making from 300–400 brl. of water/day and 504 brl. of oil.

A study is made of water production and its effects on the economics of the field. Plug-back operations to reduce water productions are briefly described. The operator producing salt water has a choice of attempting to gain a shut-off, of making arrangements for the reinjection of the water at the same time applying for an oil bonus for the water returned to the formation, of shutting in the water producer and asking for the 1 brl. of oil for each 50 brls. of water shut in, or of curtailing the water production to 10 times the allowable/day getting the oil that is produced with that amount of water. The 1 brl. of oil for each 50 brls. of water returned defrays the expense of injecting the water. If the bonus oil can be produced from the operator's own properties, he can transfer the allowable to these. Or he can purchase this oil from another producer for around $0·93/brl. If an operator has two wells on a lease, both making water, he can convert one to an injection well and take his bonus oil from the other well or another well which does not make any water. The only limit to this arrangement is the amount of water which can be handled economically and the proration restrictions on per-well production.

One fact forcing many operators to favour salt-water-production restriction and/or reinjection is the scarcity of pumping equipment. Without some means of maintaining the reservoir pressure at its present level, 1600 wells will be converted from flowing wells to pumpers during 1943. Obtaining that much pumping equipment is a serious problem. If pumping is restricted or postponed by reinjection of water then existing pumping plants can be transferred to meet the demand. A. H. N.

561. Completion Practices in North-west Wilmington Area, California. W. R. Cabeen and A. L. Hunter. *Oil Gas J.*, 28.1.43, **41** (38), 179.—Drilling and cementing practices are given first, followed by the completion programme. After testing the water shut-off and drilling the cement the hole is under-reamed. The next step is to run prepacked gravel liner to bottom, blanking off the shaly portions of the section. The electric log, run on the interval below the F_1 point (shoe point), is used to determine the intervals to be produced and those to be blanked in the combination liner. There are three sections that are usually blanked: (1) That shaly interval approximately 50 ft. in thickness occurring between the two main sandy phases of the Ranger zone; (2) the interval between Ranger (Pliocene) and Terminal (Miocene) varying in thickness from 165–190 ft., according to the particular location, its structural position, etc., and (3) the J shale, which is approximately 90 ft. thick. Cementing the blank liner sections in North-west Wilmington has proved to be the wisest procedure. The advantages of cementing the blank intervals are: (1) to assist in the prevention of liner collapse due to production of sand from below these blanked shale intervals, and the resultant removal of their support in the hole which, together with disintegration of the overlying shale by absorption of water, causes these shale intervals to move in against the liner and collapse it, which usually necessitates the expense of a redrill job. The source of water in the Ranger-Upper Terminal section in North-west Wilmington is found in thin grey sand streaks in the predominately shale intervals (2) and (3) mentioned above. Source of the water in these intervals has been found by core data and water-witch determinations, and varies stratigraphically from one fault-block to another, depending on factors governing the accumulation of fluid in each fault-block. Therefore it follows that the technology to be applied will vary according to the fault-block and the position of the well under consideration in that fault-block. A surprising number of liners in wells in North-west Wilmington have collapsed in the last few months. In all these wells the blank sections had not been given support by cementing.

(2) By cementing these blank sections the above-mentioned wet streaks occurring in these shaly intervals are cemented off, giving the well a much lower cut. This also stops the disintegration of the shale by the water behind the blank which aids in and leads to collapsing the liner. (3) If at any time it is necessary to plug the well back, it is only necessary to put a bridge-plug in the cemented blank to make an effective shut-off. In North-west Wilmington this is especially important as the J sand, in the lower portion of the hole, is in certain areas the most likely member to go wet first necessitating the plugging of the bottom of the hole.

Cementing of the blank sections is described in detail, followed by a short discussion

on gravel packing in this area of California. The paper is to be concluded in another instalment. A. H. N.

562. **Some Kansas Flooding Practices.** P. Reed. *Oil Gas J.*, 4.2.43, **41** (39), 36–37.—In the past year there have been a number of instances of operators introducing water-flooding into shoestring sands where they have been repressuring with gas or air for a number of years. In these programmes water-flooding has been applied on part of the shoestring, while at the same time the operator continues to repressure the remainder with gas or air. One operator who is doing this on a shoestring which has been repressured with gas since 1935 says that results indicate that the lifting cost with water-flooding is about half of that for producing with gas repressuring. Lifting cost for this shallow shoestring property, including depreciation of equipment as well as the regular lease expenses, but not including depletion or office overhead, has been running between 40 and 60 cents/brl. during repressuring with gas.

The water-flooded section is near the centre of the shoestring. The pattern adopted is the elongated or rectangular five-spot, 250 × 500 ft. Input wells are not located as near the edge of the shoestring as producing wells. Some of the input wells had formerly been used for injection of gas. Before converting them to water-flooding they were shot and tubing was cemented in the usual manner; results have been satisfactory. The general custom in this part of the Kansas water-flooding territory is for operators to pump rather than flow-producing wells from the beginning. One operator who turned from pumping to flowing on a fairly large scale later returned to pumping in order to produce at a faster rate. However, in some cases stopcocking is done with success in the last stages of flooding after the peak has past and production has dropped to a marginal status.

Multiple completions are described in some detail. Sources and treatment of water are briefly discussed. A. H. N.

563. **East Texas Salt-Water-Disposal Project May Set Pattern for Future.** H. F. Simons. *Oil Gas J.*, 4.2.43, **41** (39), 38–41.—The organization of the co-operative project is described together with certain of the economics involved. Injection of the salt water amounts to practically a secondary recovery project, as the returned water will maintain the natural-water drive which is forcing the oil upward and out. The rate of water influx is approximately 625,000 brl./day under present pressure conditions, as shown in a preceding article (*Oil Gas J.*, 28th January, 1942, p. 175), and if all the water is returned, the oil withdrawal may be at that rate or 550 brl./day. Maintaining the natural water drive will be much more effective than depleting the field of its reservoir pressure and producing less ultimate recovery under less efficient operation. Another eventuality to be considered is the exhaustion of the incoming water, something which has happened in other water-drive fields. While it is not expected in East Texas, it is a possibility which might cause the loss of a huge quantity of oil. The plan is eventually to inject all salt water produced in the field into the Woodbine sand, but putting the plan into operation is naturally slowed by the war effort, which prevents or delays the obtaining of equipment. Consequently, the plan will be effected through units, all being part of the system and each going into operation as soon as completed. Different plans are discussed.

The system selected consists of aeration, chlorination, more aeration and settling, filtering, and finally gravity injection into the Woodbine sand. A typical system for handling 25,000 brl./day will consist of two gathering pits of 12,000-brl. capacity each with the incoming water being aerated and chlorinated. Generally, the water will flow by gravity from the lease-tanks to the gathering pits, and will be transferred from them to the injection plants by pump pressure. The injection-plant facilities include chlorinators, a 25,000-brl. pit, eight pressure filters, and one or more injection wells. Chlorination of the salt water will be by electrolysis. About 7 volts and 400 amp. are used to effect the liberation of the chlorine. The capacity of the cells to generate chlorine is dependent on the size and number of plates. The plates are made of graphite and are 1¼ × 6 × 30 in., and four of them will give sufficient capacity for 5000/6000 brl. of salt water daily. The current necessary for the chlorination will be provided by direct-current generators driven by internal-combustion engines or by motor-generator sets. Internal-combustion engines used for this purpose are 15-h.p. output.

The chlorinators are located just ahead of the large aeration pits, sometimes in conjunction with, but separated from, a skimming pit which removes any oil from the salt water. The final filtering will be in pressure filters operating at low differential. These filters consist of assorted sands and gravels specially selected. Facilities for backwashing the filters consist of pumps and the necessary connections to change direction of flow. Details of wells, meters, cement-lined casings, etc., are given.

A. H. N.

564.* Economics of Water Flooding. H. S. Milam. *Oil Wkly*, 8.2.43, **108** (10), 15–16.—In North-eastern Oklahoma and South-eastern Kansas at the beginning of last year there were 72 water-flood projects in operation. During the year 1941 additional acreage placed under water-flood amount to 1597 acres, making the total acreage under water-flood 8454 acres. The total pipe-line runs of all oil production in North-eastern Oklahoma and South-eastern Kansas for 1941 amounted to 9,636,289 brl., of which 3,976,390 brl. of 40%, was produced from the properties under water-flood. From North-eastern Oklahoma during 1941 the pipe-line runs amounted to 6,261,664 brl., with 2,970,350 brl. or 48·2% coming from the water-flood projects. This is an increase of 327,543 brl. over the production during 1940.

From South-eastern Kansas during 1941 the pipe-line runs amounted to 3,374,625 brl., of which 1,006,040 brl. were produced by water-flood methods. This amounts to 29·8% of the pipe-line runs for the same period. At the beginning of this year the total number of water-injection wells on water-flood projects was 3370, and the number of new producers drilled will be only slightly less than that figure. The accumulative total of oil produced by water-flood methods up to the first of this year amounts to 15,525,098 brl. This production has been obtained with an oil–water ratio of 1 to 11·4 (meaning that one barrel of oil was produced for each 11·4 brl. of water injected).

The most outstanding water-flood project, and the best known, is the Forest Producing Corporation No. 1. The original 160-acre pattern having produced up to the first of this year, a total of 1,048,009 brl. of oil, or an average recovery of 6550 brl./acre. This project was started in the autumn of 1935, and is still producing about 20 brl./day. The production during the first few years was pumped from a central power, but is now being flowed. This project is located in Section 18–26n.–17e. Sections which are not responding are also reviewed.

There are a few projects that have already made a recovery of in excess of 3000 brl./acre, and a few more that have reached the 2000-brl. stage, but these are of course the elder projects. The majority are approaching the 2000-brl. stage. Costs are briefly discussed, and in general terms only. Methods of reducing costs (*e.g.*, by wider spacing) are outlined.

A. H. N.

565.* Calculation of Actual and Effective Counterbalance. E. N. Kemler. *Oil Wkly*, 8.2.43, **108** (10), 17–20.—Counterbalancing may in theory be applied to accomplish any one of many functions. It may be applied to equalize the peak torque on the equipment, to make the average torque or horse-power on the up and down strokes equal, to make the peak bearing loads a minimum, etc. It is generally applied to reduce equipment loads or size, and as such will probably reduce the peak or average torque. Practically any normal well, when properly counterbalanced for peak torque, will have nearly equal up- and down-stroke speeds and power requirements and minimum average torque. Any attempt to calculate the proper counterbalance will require the use of a dynamometer card unless some empirical formula or rule is employed. The determination of the proper amount of counterbalance from a dynamometer card may be quite difficult. The method to be used will depend on the purpose of counterbalancing. Three practical purposes are keeping of peak effective load a minimum, keeping peak torque a minimum, and balancing up- and down-stroke average torque or what is equivalent, the up- and down-stroke horse-power. The difficulties involved will depend on the shape of the dynamometer card and on the degree of accuracy desired. The square type of card is frequently identified with slow-speed pumping. In this case a counterbalance equal to the average of up- and down-stroke loads will result in equal set or effective up-stroke and down-stroke loads, equal peak torques, and will make the average torque on the up stroke equal

the average torque on the down stroke and will also make the up-stroke power equal the down-stroke power.

The paper gives an illustration of calculating counterbalance for a particular example. A. H. N.

566.* **Computing Lifting Efficiency of Oil Wells Produced by Intermittent Flow.**—S. F. Shaw. *Oil Wkly*, 8.2.43, **108** (10), 28.—Behind all calculations is the desire to estimate the quantity of gas under a given flowing pressure that is required to lift a barrel of oil under conditions of maximum lifting efficiency, or of maximum capacity of the educator. Methods of comparison for determining the quantity of gas required for continuous flow can be worked out fairly satisfactorily, but methods for determining the quantity of gas required to lift a barrel of liquid by intermittent flow are not as satisfactory, and the writer has therefore employed another basis for computing the number of cu. ft. of compressed gas required to lift liquids when employing the slug-flow type of discharge, which method might be termed the "volumetric method," because of the displacement type of flow that takes place.

Lifting efficiency when displacing oil might be compared, as a measure, with that of the volumetric efficiency of a compressor when compressing gas. The gas in the cylinder is all displaced at the end of a stroke, and is discharged, except that which remains in the clearance spaces between the piston and the head in the cylinder, or in the spaces around the valves that are not flush with the cylinder walls. In intermittent flow, gas is injected into the eductor between the slug at a higher pressure than that required just to balance the slug of liquid; it may be injected into the eductor for a slight period after the slug begins to spill over at the top of the well, even though this be at increased expenditure of power; also a portion of the bottom of the liquid slug may tend to drop back into the gas column. These factors tend to reduce the volumetric efficiency of the displacement operations, but a large number of tests seem to indicate that the quantity of gas required for this type of flow can be determined by the volumetric method within about 10% of that actually needed. If the quantity used is in excess of 10% of that computed as necessary, it would be well to examine the setup for inefficiencies in the manner in which the method is employed.

The theory of the method is briefly explained; tables are presented for the use in the calculations, and finally an example is solved and the solution discussed in some detail. A. H. N.

567.* **Constant Intake Hook-up Improves Gas-Lift Operation.** Anon. *Oil Wkly*, 22.2.43, **108** (12), 21–22.—The operator of a large gas-lift station in a western oil-field encountered fluctuating intake pressure immediately after the plant was put on the line. The shift workers were constantly changing and adjusting position of the valves on the intakes to smooth out operation cycles, frequently being obliged to pinch the intake to the point where the volume handled was insufficient to operate the gas-lift equipment at the individual wells. The problem was put up to the chief engineer with a limit on the amount of money to be spent. He proposed one solution after another, most of which called for an elaborate hook-up requiring several expensive instruments, valves, and regulators. A solution was finally reached which required only three controllers: the main pressure controlling valve and two pilots. The intake line was cut near the plant scrubber to install a flanged master-gate valve. A 4-in. by-pass was placed around this connection, into which the main pressure controller was flanged, all of this being installed below ground-level in a gate box large enough to protect the equipment and furnish sufficient space for adjustment, replacement, and maintenance. Two pilot valves, on a half-inch line from the scrubber, control the operation of the main pressure controller, which is set to operate about half-way between wide open and closed. One of these pilots is permanently adjusted to control the pressure to a maximum of around 25 lb., and is not touched again except to pack the stem at long intervals and to test for control range. The second valve is variable, which the operators may adjust to maintain any desired pressure below the maximum of 25 lb., depending on plant conditions at time of adjustment. The plant has worked smoothly since the installation of the controllers.
A. H. N.

568.* Comparison of Beam and Rotary Counterbalances. E. N. Kemler. *Oil Wkly*, 22.2.43, **108** (12), 28.—Force diagrams for upstroke and downstroke movements of pumping beam is studied for both beam and rotary balance. The important factor to be noted in connection with forces in the beam counterbalance is that the pitman bearing must be able to carry a load in either direction. If beam balance is used, the pitman and pitman bearings must be designed to work with beam balances. Provision must be made for adjustment of these bearings to prevent lost motion and bearing trouble. In most cases some beam balance can be used with the simple type pitman in use on many wells without changing the bearings. The amount which can be safely used can be determined from analysis or from experience.

The case of rotary balance is then noted. In this case the pitman is always in tension. The bearings will always be loaded in the same direction, and can be of a simpler design. The pitman and crank bearings must be designed to carry the full sucker-rod load in the case of rotary counterbalance. The balance is between the crank and well in the case of the beam balance, and, therefore, may reduce the load for which the pitman bearings must be designed. They must be designed to carry the full counterbalance in case the sucker rods fail near the top in the case of beam counterbalance. Because provision must be made to take care of conditions where sucker rods fail, there will be little difference between the size of bearing required. The bearings when only beam balance is used must be adapted to take loads in either direction. Care must be taken in the operation to see that such bearings are properly adjusted and that provisions for adjustment are furnished. When the ratio of stroke to beam length is short the counterbalance weight will act downward, and will produce only vertical components. This load may vary in magnitude only. Except for the horizontal component of the pitman pull, the load on the sampson post will be vertical. In the case of a unit with crank bearing and sampson post on the same foundation the pitman component produces only internal forces and the foundation carries only the vertical counterbalance and sucker-rod loads.

Calculations are made for rotary balance forces both for downward weight effect and radial centrifugal effects. Rotary and beam counterbalancing are studied by typical examples. A. H. N.

Transport and Storage.

569.* Experimental Data with Dusts to Determine Effects on Pipeline Transmission and Orifice Coefficients. G. M. Kirkpatrick. *Pipe-line News*, August 1942, **14** (8), 12.—Before the outbreak of war the Blaw-Knox Co., Pittsburg, P.A., in the course of investigating the operating characteristics and efficiency of a gas-cleaner of their own design, attempted to simulate conditions existing in gas transmission lines by means of glass pipe. This enabled visual data to be collected. This article summarizes the work accomplished before the war and indicates favourable lines of research for the future.

Figures are given to illustrate the way in which dust is laid down when the gas has been caused to swirl or flow in a spiral path by reason of a 90° elbow. Others illustrate the formations when flow straighteners were employed to enforce straight-line flow. Observations made during runs of this type disclosed some unexpected conditions. Where straight-line flow existed there was no observable evidence of sediment in a clear, open line. Sediment did not occur at elbows and orifice plates or in the presence of spiral flow. It seemed that the rate of progress of the moving sand-dunes bore some relationship to the velocity of gas.

To obtain some idea of what may take place in a sag or underbend in a gas line, the glass pipe was set up with one joint sloping down to a 45° elbow and the other joint sloping up and away from the elbow. Less than one quart of oil was introduced in the upstream end of the line, and dust was then blown in. Dust was deposited and held by the oil in the downward-sloping line. Of greatest interest, however, was the heavy deposition of oily dust in the upstream half only of the elbow. The oil collected and remained in the downstream half of the elbow. Similarly observations were made with the glass pipe and elbow placed to resemble an overbend.

Summarily as a result of these and similar experiments useful data were also obtained on the manner in which dust is laid down in a gas line; the circumstances and way in which dust moves in the line; action of dust and liquid on an orifice plate; and effect of dust and liquid on orifice meter measurement. H. B. M.

570.* **Somastic Coating Effects Substantial Steel Savings.** Anon. *World Petrol.*, November 1942, **13** (12), 52.—In the past it has often been the practice to use steel pipe in weights ranging from 25 to 50% or more in excess of the minimum required by line-operating pressures, when laying pipe-lines in corrosive soils, in order to anticipate corrosion losses. An alternative is to use pipe of the thickness required by operating pressures and apply protective measures, such as coating. In such cases it is essential that the coating should be able to withstand handling, etc., and give the desired degree of protection throughout the useful life of the line. In normal times the cost of such protective measures must be balanced against the cost of the additional steel required of the alternative method. In war-time, however, economy of steel usage assumes a greater importance.

One method of pipe protection which has proved successful in Bureau of Standards tests, and in practice, is to coat the pipe with asphalt mastic, known commercially as Somastic pipe coating. It consists of asphalt, graded mineral aggregate, and long-fibre asbestos, mixed by weight and batched at carefully controlled temperatures. The reinforcement of the mixture by the use of limestone dust and sand, as well as the thickness of the applied coating, develops sufficient strength to withstand the handling imposed by normal pipeline construction methods. A firm bond of coating to pipe is secured by the application of a special primer coat. The mastic may be applied at central or railhead plants adjacent to the line, or, by the use of travelling equipment, on the line itself. By the use of lighter piping a saving in steel usage of 33% is estimated, and the protective material can be applied at a cost lower than the value of the steel replaced.

Application of this coating method to the relaying of old lines is described. Much pipe which would otherwise have to be discarded can be re-used after reconditioning and coating. R. A. E.

Gas.

571.* **Poe Sees Need for More Natural Gas Lines to Meet Increased Demand.** Anon. *Pipe-line News*, December 1942, **14** (11), 15.—At a recent A.P.I. meeting, E. Holley Poe, Natural Gas and Natural Gasoline Director of P.O.C., is reported to have stated that the natural gas demand in 1942 would exceed that of 1941 by 25% and in some areas by as much as 40%. He estimated that probable consumption in the United States in 1942 would approach 3 trillion cubic ft., or the approximate equivalent in heat energy of 124 million tons of coal, 879 billion kilowatt hours of electricity, or 540 million barrels of fuel oil.

Problems confronting the natural-gas industry are likened to those arising in the production, refining, distribution, and utilization of oil and its many by-products. It has to be remembered, however, that the natural-gas industry is concerned with a well-to-burner operation, and large reserves must be kept available in readiness for a sudden peak demand.

Problems resulting from the impact of war are summarized thus: increased demands by both war industries and private industries; lack of materials to expand facilities; shortage of man-power; increased expenses; heavy tax burden; expected requirements of natural gas, natural gasoline, and related hydrocarbons by all phases of the war effort; need for relief during the war period from express or implied covenants in leases by reason of limited supplies of critical materials which prevent the orderly drilling of wells on such leases. H. B. M.

Hydrogenation.

572. **Patents On Hydrogenation.** A. Pott. U.S.P. 2,308,247, 12.1.43. Appl. 3.12.38.—In a process of hydrogenating distillation extraction products from coal, the coal is extracted with a solvent, the extract is filtered and then hydrogenated. The process is improved by drawing off the substantially unhydrogenated sludge arising in the hydrogenation stage and adding this to the crude coal-extract solution prior to filtration. H. B. M.

Polymerization and Alkylation.

573. **Patents On Polymerization amd Alkylation.** A. Wassermann. E.P. 551,512, 25.2.43. Appl. 23.9.41.—Catalysts are prepared by heating a mixture of copper

sulphide, copper sulphate, phosphoric acid, and water to a temperature higher than 90° C. The catalyst is used in the production of olefines of relatively high boiling point from olefines of lower boiling point. H. B. M.

Synthetic Products.

574. New Process Increases Output of Butyl Rubber Without Greatly Altering Plant. Anon. *Pipe-line News*, August 1942, **14** (8), 12.—W. S. Farish, president of Standard Oil Co. of New Jersey, reports that the five butyl plants being built for the U.S. Government were originally designed to take care of 60,000 tons per year. Improvements in the manufacturing process have, however, enabled the Company to modify the design of the plants only slightly and yet raise their capacity very substantially.

A new programme approved by the War Production Board raises the preparation capacity of *iso*butylene from 60,000 to 90,000 tons a year. It is believed that the additional *iso*butylene required to take advantage of the full potential butyl capacity can be obtained by the Government.

Mention is also made of Flexon, which, though not actually as good as butyl rubber, makes better tyres than reclaimed rubber. *iso*Butylene is used in its manufacture. Developments of these two substitutes are indicative of the intense research and development work now being undertaken to further the synthetic rubber campaign. H. B. M.

Refining and Refinery Plant.

575. X-Ray Analysis and Chemical Scale Removal. S. C. Morian. *Refiner*, January 1943, **22** (1), 12–15.—Recently properly selected chemical solvents were applied to remove scale from an ammonia absorption refrigeration plant used by a large Gulf Coast Refinery. The equipment that was descaled consisted of two condenser units and three absorber units. Each condenser unit contained 324 2-in. × 16 ft. 11-gauge tubes, a total of 1360 sq. ft. of surface; each absorber unit contained 691 ¾-in. × 16 ft. 14-gauge tubes, a total of 4358¼ sq. ft. The grand total square feet of surface to be cleaned was 15,774. The materials used in the removal of scale from this equipment consisted of 2750 gallons of specially prepared solvents, capable of disintegrating and dispersing the scale, and special pumping and heating equipment. The heating units were used to raise the temperature of the solvents, thereby increasing the solution rate. The latter was important, since it was impossible to shut down the units for longer than 24 hours. The solvent pump discharge was tied into the absorber first in line. Cold solvent was then pumped into the system to establish circulation and to remove air pockets. A few pounds back pressure was held on the discharge to keep the units full. This was necessary to avoid a siphoning effect. As soon as the units were full and a circulation rate of two brl./minute was established, the heating unit on the solvent pump discharge line was cut into the system gradually in order to avoid unnecessary stresses due to sudden temperature rises, and the actual treatment began. A check on the effect of the solvent on the equipment was maintained at all times by observing the effect on special metal test strips which were placed at strategic points in the solvent input and discharge lines. No extra labour was necessary to complete the successful chemical removal of the scale deposits, and fire hazards and other ordinary attendant dangers were reduced to a minimum, since it was unnecessary to use mechanical types of cleaning equipment. All the scale was removed, leaving no nuclei for new scale formation. Data are given

The selection of the solvent can only be made if the composition of the scale, the solute, is known. X-Ray analysis appears to be one of the most rapid and economic methods. The method is described and illustrated, references to more detailed papers by Hull and others on this method of X-ray analysis being given. A. H. N.

576. Effect of High Pressure Extrusion on the Adsorption Capacity of Floridin. R. C. Amero and R. G. Capell. *Refiner*, January 1943, **22** (1), 22–26.—The effect of extrusion of clay on its efficiency as a percolator is studied mineralogically. Of much importance is the fact that the orientation of the clay mineral flakes in the rods is different from those in the crude fuller's earth. In the rods there is a marginal zone in which there is some parallel orientation of the clay mineral flakes. With high

magnification this zone can be seen to be composed of small masses of clay minerals. Each mass is composed of clay mineral flakes in uniform orientation similar to the crude earth. The orientation of each mass is slightly different from that of its neighbour, so that the effect between crossed-nicols is that of a patchwork of extremely minute masses, each with a different orientation. There is therefore an important difference in the texture of the crude and extruded earth. This cannot be well demonstrated by photomicrographs, because it is evident only when the stage of the microscope is rotated. It can, however, be demonstrated to an audience by an apparatus for projecting on a screen the microscopic image as it is obtained from a thin section. Extrusion does not accomplish any mineralogical change. The X-ray diffraction patterns for the extruded and unextruded earth are identical. Extrusion undoubtedly results in an increase in the amount of active adsorbent surface exposed. Floridin fuller's earth, the most widely used oil decolorizing medium in the United States, has been enhanced in value about 30% in 20 years, largely through the addition of an extrusion step in processing. Extrusion brings about profound changes in the microscopic and possibly the submicroscopic character of the clay, which will, when thoroughly understood, throw a new light on the properties of clays. A. H. N.

577. An Application of Arc-Welding in the Maintenance of Heat-Transfer Equipment. W. H. Parlette. *Refiner*, January 1943, **22** (1), 27–28.—The short paper describes, with illustrations, the method adopted in maintaining the efficiency of a heat exchanger through arc-welding of baffles which have been corroded and restoration of the tube bundle. A. H. N.

578. Fractionating Tower Fabricated From Tank Steel. E. Sterrett. *Refiner*, January 1943, **22** (1), 30–32.—A fractionating tower, to be used in extracting toluene from the stream on a recycling plant, was manufactured from a battery of idle 55,000-brl. storage tanks. The paper describes certain procedures. A. H. N.

579. Patents On Refining and Refinery Plant. C. Weizmann. E.P. 551,215. 12.2.43. Appl. 6.8.41.—In plant or apparatus used for the thermal treatment of materials in the vapour phase which are liable to give carbon deposits, copper is used as a lining. The copper is in the form of pure copper or oxidisable alloys of copper, and is used either as the inner surface of the tube or vessel or as a coating thereon. Plant embodying this lining may be used in the cracking of oils and tars, aromatization of aliphatic oils, destructive hydrogenation of carbonaceous substances, polymerization of unsaturated hydrocarbons, etc. H. B. M.

Fire Prevention.

580. Methods of Combating Fires In Oil Storage Tanks. J. D. McCamey. *Oil Gas J.*, 3.12.42, **41** (30), 33.—The article is taken from a manual devised to assist field employees in the protection of crude-oil storage tanks. Steel-roof tanks equipped in an approved manner practically eliminate the possibility of fires from normal causes, but the importance of regular inspection and maintenance of safety devices is stressed, and parts requiring special attention in cone-roof tanks and tank openings and on floating roof tanks are mentioned. All tank-roof equipment, where possible, should be of vapour-tight design, and gauge or thief openings should be provided with non-ferrous seats. The capacity of the fire wall around crude storage should be 125% of the storage capacity unless deflecting couples are provided. The area should be kept free of vegetation, and should drain to a point where a pipe of adequate capacity should be installed. The drain-pipe should be below actual ground level and equipped with a low-pressure valve placed outside the fire wall and protected from freezing. Drain-valves to be closed except when actually draining water. Adequate equipment, mechanized and manual, to construct auxiliary dykes, fire walls, pipe lines, etc., in emergency, should be readily available.

The use of steam as extinguishing agent should be limited to cases where other agents are not available, and then applied safely where vapours only are burning at a leak of limited extent. Foam produced by chemical reaction between sodium bicarbonate, a foam-producing ingredient and aluminium sulphate is considered the

most effective in combating tank fires. Difficulties of maintenance of proper solution preclude the 2 solution system. For a dry-powder installation recommendations are: A minimum of 4 lb. of powder per sq. ft. of oil surface of the largest tank to be protected, a rate of foam application of ¾ g.p.m. per sq. ft. of surface protected. Since 1 gal. of water with 1 lb. of powder creates 8 gal. of foam, requirements for a tank of 80,000 brl. capacity and 117 ft. diameter would be 22 tons of foam powder and a water delivery rate of 1012 g.p.m. at a pressure of 100 lb. per sq. in. The number of fixed foam installations on tank farms is limited, probably due to cost and difficulties of obtaining adequate water supply.

Precautions to be observed in arranging transfers to other tankage from a burning tank are given. Crudes which contain even small quantities of sediment and water are subject to the boil-over phenomenon, but they will normally burn for a period of 6 to 8 hours before it occurs. Digging a ditch at the inside toe of the fire wall during the waiting period will assist in retarding the resulting flow. Normally the downwind side constitutes the greatest hazard and consideration should be given to this in erection of auxiliary fire walls, etc., outside the regular one.

As a precaution against ignition by lightning, resistance tests should be made if there is any doubt, and if the resistance exceeds 25 ohms special grounding connections to the tank installed. Means of dealing with grass fires are suggested and the importance of good housekeeping stressed.

There should be a clearly established procedure for handling reports, equipment, and manpower in the event of a fire. The 3 major types of fire recognized are: (1) a vapour fire in which no appreciable amount of any other product is involved, (2) a vapour and petroleum fire, (3) an oil-surface fire of major importance, with vapours controllable by extinguishing the oil fire. Vapour fires are subdivided into cases where the vapour mixture between the roof and liquid stores is (*a*) too rich to explode, (*b*) explosive.

Characteristics of these two types of vapour fire are described. Possible causes of outbreak and precautions to be observed in dealing with each individual type of fire are given and the method of extinguishing considered most applicable to each is described in detail. R. A. E.

Physics and Chemistry of Hydrocarbons.

581. Sulphur Compounds from Panuco Gasoline. W. Friedmann and C. Canesco. *Refiner*, January 1943, **22** (1), 1–5.—The sulphur compounds present in the gasoline cut, range of 75–140° C., have been isolated and identified by the following procedure: An acid sludge which had been formed in refining Panuco gasoline with concentrated sulphuric acid (E.P. 175° C.) was drawn, settled, separated from the gasoline, and diluted with ice and water. The light tar which separated was neutralized with lye, and steam distilled until no more oil came over. A considerable amount of resinous matter not yet investigated remained in the still, 60 litres steam distilled, golden-yellow oil, D_{25}–0·917, were recovered; its terpene-like odour was not unpleasant in spite of the high sulphur content of 21·7%. 4·5 litres of sludge oil were roughly fractionated into twelve cuts. Each cut was redistilled several times, taking 2° cuts, and these cuts were then combined into groups depending on their gravity or sulphur content; they were submitted to further fractionation until fractions of a certain boiling constancy were obtained.

In no case were pure sulphur compounds obtained by fractionating overhead products. Later investigation will determine whether azeotropic mixtures are formed or not. Even the cuts which, according to the boiling points, could be considered as almost pure were not suitable material for the preparation of derivatives which had to identify the sulphur compounds. On the other hand, the preparation of the mercuric chloride additive products and their recrystallization until the melting points remained constant proved a practical way. Repeated recrystallizations were inevitable when the alkylated thiophanes appeared as isomers, which, as a rule, were roughly separated in three or four recrystallizations of the additive products. The purified additive salts were decomposed by sulphide of sodium, the liberated thiophanes driven off with steam, the aqueous distillate extracted, and the dry extract rectified. Only the thiophanes are mentioned because no sulphur compound so far separated from a main cut or from an intermediate one, could be identified as open-chain sulphide.

The identification of the thiophanes is described in detail. The sulphur compounds found in small fractions, range of few degrees except for the first with a range of 82–110° C., are discussed. The full conclusions to be drawn from the work are postponed for a second publication. A. H. N.

582. Thermal Cracking Chemistry. P. H. Faust. *Refiner*, January 1943, **22** (1), 6–8.—An elementary explanation of the chemistry of cracking is given, with a description of simple hydrocarbons and their structural formulæ. It is stated that only the olefines do not occur in detectable amounts in the crude itself. A. H. N.

583.* The Formation and Structure of Some Organic Molecular Compounds. J. Weiss. *J. Chem. Soc.*, April 1942, 245–252.—In his study of organic molecular compounds the author confines himself to the two typical classes in which the colour of the molecular compound is deeper than that of either of the two components. These include on the one hand compounds of benzoquinones, or substances derived from them, with aromatic hydrocarbons, amines, or phenols. The second class includes molecular compounds of nitro-compounds with unsaturated hydrocarbons and their derivatives. It is claimed that a modification and extension of a theory advanced by Hammick and Sixsmith, and Gibson and Leoffler to the whole group of molecular compounds explains their formation and structure in every detail. These workers suggested a polarization mechanism similar to an oxidation-reduction reaction for the formation of molecular compounds between aromatic amines and nitro-compounds.

The author believes that formation of the deeply molecular compounds is due to a complex molecule, essentially ionic in character, which is formed from the two components by an electron transfer from the unsaturated hydrocarbon or its derivative (donor A) to the quinone or polynitro-compound (acceptor B) according to the net reaction

$$A + B \rightleftharpoons [A] + [B]^{-}.$$

The following points are discussed in support of this theory :

(*a*) Structure and rate of formation of the molecular compounds; (*b*) the heats of the formation; (*c*) the equilibrium in solution (and the influence of hydrostatic pressure on it); (*d*) colour of the molecular compounds; (*e*) crystal structure and intermolecular distances; (*f*) the dipole moment in solution; (*g*) the electrical conductivity in solution; (*h*) relationship to the semiquinones and other free radicals and radical ions. H. B. M.

584. Emergency Use of Oil-Coal Suspensions as Colloidal Fuel. W. L. Faith and H. W. Zabel. *Refiner*, January 1943, **22** (1), 9–11.—The technical and economic problems of mixing coal and oil are being studied by the authors, but only preliminary results have been obtained so far. These results indicate that a high-speed propeller mixer is satisfactory for preparing fuels in which the final viscosity is not over 80 seconds Saybolt Furol. This figure is only approximate, but mixing experiments to date indicate that above this value thorough mixing does not take place. It is obvious that as the viscosity of the mix increases, more power is necessary, and that as the coal concentration is increased, a point is reached where the suspension loses most of its liquid characteristics. The final viscosity during mixing can of course be lowered by raising the temperature of the oil, and this procedure is recommended. An equation has been developed by means of which the viscosity of the suspension can be calculated directly from the viscosity of the oil itself at the same temperature, and the volume concentration of coal in the suspension. This equation is (for 200-mesh coal):

$$\frac{\mu_f}{S_f} = \frac{38{\cdot}4}{38{\cdot}4 - C_v} \cdot \frac{\mu_0}{S_0}$$

where μ_f = kinematic viscosity of the suspension.

$\frac{\mu_0}{S_0}$ = kinematic viscosity of the oil.

C_v = volume percent coal is mix.

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For 325-mesh coal the constant 38·4 should be replaced by 37·5.

Kinematic viscosities can be converted to Saybolt Furol seconds and vice versa by means of the usual viscosity conversion charts. It is recommended that in no case should an attempt be made to prepare fuels containing more than 50% coal by weight. 40% by weight appears to be a more satisfactory upper limit.

The problem of storing and handling is mainly that of the settling of the coal. This is discussed in full.

In calculating the friction head in pumping colloidal fuel through pipes, the following equations may be used: For viscous flow (low flowrates and coal concentration below 38% by volume)

$$\frac{H}{L} = \frac{V\mu_0}{D^2\rho_0} \cdot \frac{K_0}{K_0 - C_v}$$

where D = diameter of pipe in feet; H = difference in static head between two points in a pipe, feet of flowing substance; L = length of pipe, feet; V = mean velocity of flow in pipe, feet/sec.; μ_0 = coefficient of viscosity of oil, pounds/ft. sec.; ρ_0 = density of oil, lbs./cu. ft.; C_v = percentage coal by volume in suspension; K_0 = 38·4 for 200-mesh coal. For turbulent flow the usual plots of Fanning friction factors *vs.* Reynolds number may be used, assuming the viscosity and gravity of the oil-coal suspension are the same as those of the oil medium itself. This assumption introduces only a very slight error. For plastic or "plug" flow (coal concentrations above 38% by volume)

$$\frac{H}{L} = 32\left[\frac{\tau_y}{g\rho D} + \frac{\eta_s}{g\rho D^2}\right]$$

where τ_y = yield value of plastic fuel, lb./sq. ft.; η_s = coefficient of rigidity of fuel, lb./ft. sec.; g = acceleration due to gravity = 32·2 ft./sec.^{2}. In practically all cases of industrial importance, only viscous flow will be encountered, and calculations should be based on that assumption.

The economic factors involved are discussed together with typical colloidal fuel preparation plant. A. H. N.

585.* A Method for the Accurate Analysis of Gaseous Mixtures. C. H. Bamford and R. R. Baldwin. *J. Chem. Soc.*, January 1942, 26–39.—The authors state that various inherent sources of error render standard methods of gas analysis unsuitable for adaptation to precision measurements on mixtures containing a number of constituents. In their experience, analyses reproducible to 0·1–0·2% for the main constituents of the mixture can be obtained with a standard Bone and Wheeler apparatus, but the absolute accuracy is usually less than this, and the presence or absence of constituents in concentrations of 0·1–0·2% is always in doubt. It is claimed that the method described in this paper gives results accurate to 0·03% for individual constituents. The method of analysis involves successive quantitative conversion of the components of the gas into carbon dioxide and/or water, which are measured separately. Measurement is effected by determining the pressure exerted in one of two standard volumes of known ratio. This enables either large or small amounts of gas to be measured with accuracy.

The method described has been tested with various mixtures of known composition and its accuracy thus checked. H. B. M.

Analysis and Testing.

586.* Viscosity Measurement and Viscosity Index. J. C. Cragg and E. A. Evans. *Journ. Inst. Petrol.*, April 1943, **29** (232), 99–123.—The paper and its long discussion analyse the effects of errors in viscometry of the accuracy with which the viscosity index may be returned. The possible accuracy of viscometry as laid down by the recommendations of the Institute of Petroleum are also discussed. A. H. N.

Motor Fuels.

587. Substitutes for Petrol in France. E. Kalmanovsky. *Petroleum*, December 1942, **5** (12), 203.—The total quantity of gasoline and substitutes available in France in

1941 was equivalent to about 700,000 tons of gasoline, and about half of this was represented by diesel oil and gasoline released by the Germans. These releases cannot be counted on in future, and, although an increase in synthetic motor-fuel production is planned, no increase in power alcohol output can be expected. It is therefore by the use of solid fuels for gas producers that a solution must be sought. Increases in charcoal and wood for gas producers are planned to provide the equivalent of 420,000 tons of gasoline in 1943, but this quantity is insufficient for the requirements of the 100,000 heavy lorries fitted with gas producers. The possibility of using peat with a water content of 30–40% and ash content of 25% for this purpose by the Gazes system has been proved by trials, and plans to increase production of such peat to 200,000 tons in 1942 were made. Conversion of diesel engines to operate on producer gas either by (*a*) conversion to spark ignition or (*b*) starting on fuel and subsequently operating with gas is also being investigated. The possibilities of steam traction are being studied. R. A. E.

588. News from Japan. Anon. *Chem. Tr. J.*, 5.2.43, **112**, 130.—According to the Japanese, the output of natural rubber in the Netherlands East Indies and Malaya is not being curtailed. The surplus is being processed into gasoline by dry distillation of Hevea rubber and subsequent alkylation and hydrogenation of the low-boiling hydrocarbons produced. A factory has been built at Kuala Lampur, and the first unit capable of producing 100 tons a month of high-octane gasoline is said to be in operation. It is also proposed to use oil-refinery equipment in Japan for the purpose.

Oil-wells at Tarakan are said to be in commission again, and Wohokama (Java) refinery to have resumed operations on crude from Kroeka field, the output of which is expected to be reduced to 200,000 tons a year. R. A. E.

589. Patents on Motor Fuels. Standard Oil Development Co. E.P. 551,237, 12.2.43. Appl. 29.12.41.—In a process for the isomerization of paraffin hydrocarbons the reaction is conducted in the presence of a Friedel–Crafts type catalyst and a quantity of an alkyl halide which is equal to about 50–150% by weight of the hydrocarbon present. The alkyl halide acts as a mutual solvent for the catalyst and the normal hydrocarbon which is to be converted.

Anglo-Iranian Oil Co. E.P. 551,644, 4.3.43. Appl. 20.3.40. *iso*Paraffins are produced from normal paraffins by contacting the latter with a catalyst prepared by heating together aluminium halide and hydrated aluminium chloride to a temperature at which reaction takes place between them. The hydrated aluminium chloride is not present in sufficient quantity completely to hydrolize the aluminium halide.

International Catalytic Oil Processes Corp. E.P. 551,663, 4.3.43. Appl. 28.8.41. Gasoline of relatively high octane number and of increased stability is produced by catalytically cracking a gas oil in the presence of a used catalyst. Gasoline is recovered from the ensuing reaction, and this is afterwards subjected to catalytic reforming in the presence of fresh or regenerated catalyst.

E. T. Layng. U.S.P. 2,307,689, 5.1.43. Appl. 29.2.40. Olefinic hydrocarbons are converted into hydrocarbons of higher-boiling points by contacting them at a high temperature with a catalytic material consisting of a mass of porous granules of supporting material impregnated with material prepared in the following way. A complex of ammonia and a metal pyrophosphate capable of reduction to a polymerization catalyst are heated to a temperature of about 750° F. in a non-reducing atmosphere for a sufficiently long period of time to effect regeneration of the metal pyrophosphate. H. B. M.

Lubricants and Lubrication.

590.* An Investigation into Reclamation Practice. 1. Passenger Transport Undertakings. Anon. *Petroleum*, July 1942, **5** (7), 112.—This article discusses the information obtained by a questionnaire to more than 200 passenger transport companies and corporations.

Five types of reclaiming plants appear to be used and these can be grouped as follows:

(*a*) Mechanical filtration without the use of adsorbents, chemicals, etc.
(*b*) Filtration with adsorbents.
(*c*) Alkaline washing and settling treatment.
(*d*) Combined chemical and physical treatment.
(*e*) Centrifuges.

Mechanical filtration does not of course remove fuel dilution or acid content from a used oil, but it has proved sufficient in a number of cases. The questionnaire shows that 72% of the operating firms use one particular make of mechanical filter.

Filtration with adsorbents, if carried out efficiently, will produce an oil free from all suspended matter and acid bodies. A high degree of decolorization is also obtained. 15% passenger transport undertakings are using a plant operated on this principle.

Washing with alkaline solutions and subsequent settling do not appear to offer any advantage over adsorbent filtration, and only 5% of the transport companies used this method. The more complicated process of giving the oil an acid wash followed by clay was favoured by only 4% of the operating firms.

Centrifuging has not become a very popular reclaiming method, and only 3% of the companies were stated to be using this process.

This investigation also dealt with the extent to which used oil is reclaimed, and it is considered that about two-thirds of the waste oil which could actually be recovered is in fact reclaimed or used in the most appropriate way. The reclaimed oil is used instead of fresh oil in 21·5% cases, for topping up in 58% cases, and for filling crank-cases (topping up being carried out with fresh oil) 14%, the remaining miscellaneous uses accounting for the balance of 6·5% cases. D. L. S.

591. Low Temperature Characteristics of Greases. T. A. Maxwell. *Refiner*, January 1943, **22** (1), 16–18. *Paper Presented before National Lubricating Grease Institute (America).*—A specific phase of service requiring a special lubricant has been the exposed bearings of military aircraft. These may alternately be roasted under tropical suns and chilled to perhaps 100° below zero on nocturnal flights at high levels. The study covered in this paper was undertaken as background for fabrication of lubricants suitable for such service, to establish the rôle of different soap bases and different oil viscosities in determining the behaviour of greases in ball-bearing service at low temperatures. To evaluate the performance of the test lubricants at low temperatures, the torque test outlined in Army–Navy Specification AN–G–3 of 30th May, 1942, was used. An eight-ball 204 open bearing was packed with 5 gm. of grease, closed with slip-fit shields, and run in 100 turns each way. The bearing was then chilled on a straight-line curve to test temperature in 2 hrs. and soaked for 1 hr., rotating two turns every 15 min. At the end of the soaking period the time necessary for a complete revolution with 2000 gm. cm. applied torque was determined. The apparatus is described and illustrated diagramatically. Another apparatus used was a modified form of the British Air Ministry's Specification DTD 201, "Controls Lubricating Oil." The results are discussed.

In summary it may be stated that the low-temperature bearing torque characteristics of greases fabricated from different metal bases and low-viscosity-index oils appeared to be dependent chiefly on the viscosity of the oil used. Barium greases seemed to stiffen somewhat above the average of the other greases tested. Since the use of very light oils is dictated by low-temperature requirements, part of the problem lies with the refiner to produce stocks of the best possible volatility characteristics for the grease compounder to try his art on. Much work remains to be done in determining the effect of viscosity index, of phenomenal pour points, of blending agents, and of extreme pressure and/or oiliness additives which may be added to light oils.

A. H. N.

592. Patents on Lubricants and Lubrication. T. G. Rolhner and L. H. Sudholz. U.S.P. 2,308,427, 12.1.43. Appl. 16.10.40.—Vinifera palm oil is added to a mineral lubricating oil to impart to it enhanced extreme pressure lubrication characteristics. Alternatively sulphurized Vinifera palm oil which has been reacted with phosphorus may be used for this purpose. H. B. M.

Asphalt and Bitumen.

593. Patents on Asphalt and Bitumen. J. T. Hines. E.P. 551,765, 9.3.43. Appl. 28.10.41.—In the manufacture of asphaltic paving mixtures two different sizes of aggregate, one coarse and the other fine, are first independently coated with a binding agent. The coarse aggregate is coated with only so much binder as will form a thin film or coating on each fragment, but not sufficiently to permit the mass being pressed to a rigid condition. The fine aggregate is coated with the least amount of binder required to render the mass easily compressible without being rigidly cemented together. The two coated aggregates are then mixed together in the proportions to fill in, with the fine material, the voids in the coarse.

R. L. Ortynsky. U.S.P. 2,308,245, 12.1.43. Appl. 28.6.41. A Mexican-type paving asphalt is produced by oxidizing an asphalt having the following composition: Asphaltenes 1·5–5%, petroleum resins 55–65%, aromatic oil the balance. The resins and the oil have specific dispersions above 200 and flash points above 500° F. The oxidized asphalt has an asphaltene content of 50–60% and a softening point of at least 360° F. The oxidized asphalt is fluxed with 1·1–1·6 parts of petroleum extract per part of oxidized asphalt. The resultant fluxed asphalt is blended with a hydrocarbon distillate having a Saybolt viscosity between 400 and 1100 at 100° F. and a viscosity index above zero. The blended asphalt has a penetration of 25–200 at 77° F.

H. B. M.

Special Products.

594. Naphthenic Acids and Soaps. Anon. *Seifensieder-Zeitung.*, 8.7.42, **69** (14), 211.—A brief review is given of information from various sources (without references) on the manufacture, properties and applications of naphthenic acids and soaps. The acids are derived from the acid sludge from the refining of distillates by extraction with *ca.* 5% NaOH solution, and hydrocarbons are removed from the resulting emulsion by vacuum distillation or by dispersing the emulsion in water and mixing with hydrocarbon soluble and water-soluble solvents (*e.g.*, toluene and acetone) causing separation into two layers. The acids are recovered from the aqueous layer by precipitation with SO_2 and H_2SO_4, but require distillation to give a sufficiently pure product. Refining is effected with acid and clay, or by vacuum or superheated steam distillation or extraction with aniline. Neutralization of naphthenic acids with alkali yields soft viscous soaps easily soluble in water and of good foaming power. They are not hardened by salts and alkali, and can take up large quantities of salts, not being susceptible to electrolytes. By combination with fatty acid, soaps, electrolytes, perfumes, etc., a variety of useful soaps can be prepared. The neutral potassium naphthenate is stated to have strong bactericidal and germicidal properties. Use in the textile industry is restricted by the strong odour, necessitating the use of the more highly refined grades and of perfumes. The soaps are also used in textile emulsions—*e.g.*, sizes prepared from neutral fat, naphthenic acids, and aqueous soda or borax solutions, these being easily removed by washing. Cotton yarn is softened by the use of 0·6–1·5% of naphthenic acid sulphonate, also used as a textile finisher. Pests are controlled by the use of ammonium naphthenate in combination with hydrocarbons, bases, and aromatic nitro-compounds. Mixtures of equal parts of potassium naphthenate and sodium fluoride are used for the preservation of timber, while copper naphthenate is used to impregnate timber to control pests. Salts of heavy metals and of aluminium are relatively insoluble in water but subtle in hydrocarbons, and are prepared by treating the acid with a solution of the metal salt, washing with hot water, and dehydrating. Metallic naphthenates are used in the manufacture of lacquers, in printing, and in painting. A solution of naphthenic acid in turpentine is used as a rust-preventive. Calcium naphthenate is stated to improve the elasticity of acetate films and to be used in drilling and batching oils. Medical uses of the metallic naphthenates include a mixture of lithium naphthenate and olive oil for curing throat and skin diseases. Triethanolamine naphthenate is used to clarify liquid soaps. Esters of naphthenic acids are used in the perfumery industry. Tests normally carried out on naphthenic acids include water content, acid value, iodine value, and unsaponifiable content.

C. L. G.

595. Dangerous Anti-freezing Solutions. Anon. *Technical News Bulletin*, U.S. National Bureau of Standards, March 1943, No. 311, 17.—Attention is directed to the serious dangers of corrosion likely to result from the use of anti-freezing solutions containing calcium chloride and other salts in automobile cooling systems. Their use in all Government-owned motor vehicles has been prohibited, and the manufacture of anti-freezes compounded with inorganic salts or petroleum distillates has now been forbidden. Irreparable damage can be done by corrosion of water-pumps and cylinder heads, particularly if of aluminium alloy, and of radiators, particularly if of copper. No inhibitors have been found of any value under practical conditions. Determinations of specific gravity, evaporation tests or a simple chemical test (with silver nitrate) will indicate the presence of brine solutions. C. L. G.

596.* Wartime Chemicals from Natural Gas. Part 2. G. Egloff. *Petrol. Times*, 20.3.43, **47** (1191), 136–137. (See also *J. Inst. Petrol.*, April 1943, **29** (232), 124–134.—The whole paper is published here in one part.) Toluene production and synthesis of explosives from natural gas are discussed. Nitroparaffin from natural gas may well develop into one of the newer and valuable sources of high explosive. Methane gas when nitrated produces tetranitromethane. This compound is the most destructive explosive known to man, and is extremely difficult to handle. About 20 years ago, in a university laboratory in Switzerland, work was in progress with tetranitromethane, which is usually a reaction product of toluene nitration in small concentrations. Ten grams of this substance killed 10 individuals, wounded 20, and nearly wrecked the building. No commercial process has been worked out to make this product available for use by the armed forces

Anaesthetic and agricultural uses for products from natural gas are then discussed, and the paper ends with a discussion of plastics and substitute fats for food.

A. H. N.

597. Patent on Special Products. Standard Oil Development Co. E.P. 551,852, 12.3.43. Appl. 27.12.40.—In hydrocarbons such as lubricating oils, or natural or synthetic rubber, there is employed as oxidation inhibitor, a polyvalent metal salt of a dehydroxy dialkyl diaryl sulphide or polysulphide or polymers of such compounds, or their selenide or telluride analogues. At least one of the valencies of the metal in the salt is connected to an alkyoxy group. H. B. M.

Coal and Shale.

598.* The Primary Gaseous Products of Carbonization. L. Bolton, J. E. Cullingworth, B. P. Ghosh, and J. W. Cobb. *J. Chem. Soc.*, April 1942, 255.—This paper reports the results of investigations of the products of carbonization of a variety of substances differing in constitution and oxygen content—namely, cellulose, bakelite, glycerine, petroleum coke, anthracite, and New Hucknall and Sharlston Wallsend coals. In each case the substance was heated in stages of 100° in a vacuum up to 1100° or more. Gas formed at each stage of fractional distillation was collected, measured, and analyzed.

In a discussion of results obtained and tabulated in this paper attention is directed to the general similarity in the nature and temperature sequence of the primary gaseous products of decomposition from substances of such widely differing composition and complexity. Decomposition invariably occurred in two phases: up to 600° the gaseous products were accompanied by liquids which by their removal were obviously responsible for the progress towards a common type of solid residue; in the second phase from 700° upwards there were no liquid products, but always a dominating emission of hydrogen, also widely differing quantities of carbon monoxide. X-Ray examination of cellulose and glycerine residues revealed an early breakdown of the original structure, followed by a repatterning of the carbon atoms in a hexagonal graphitic network visible at 400–500° and more distinct from 800° upwards.

Correlation of all results obtained confirms Burgess and Wheeler's conclusion in regard to coal that there is a critical temperature of decomposition in carbonization, marked by greatly increased evolution of hydrogen at 700–800°. It would appear, however, that this is not a special property of coal or of any of its petrographic con-

stituents. It is a normal feature of molecular condensation in solid residues formed at lower temperatures during carbonization. H. B. M.

599. Fuel for Producer Gas. J. Devon. *Petroleum*, December 1942, **5** (12), 201.—Limits necessary in respect of size, ash content, and moisture content of anthracite used as producer-gas fuel for vehicles in the U.K. are given, and the reasons for such limitations described. Activation of the fuel by deposition of sodium carbonate on to its surface by immersion in a solution of the carbonate is claimed to increase ease of starting and acceleration, increase gas production, and to produce a softer clinker, less liable to stop gas production. Critical air-blast values—*i.e.*, the amount of air in cu. ft. per min. necessary to maintain combustion—are given for wood charcoal, some coals and manufactured coal fuels. Volume/weight relationships for anthracite, charcoals, and coke are shown. General characteristics of coke fuels vary somewhat from those of natural fuel, but they permit of operation in the same plants, although giving a smaller mileage for the same producer hopper size. R. A. E.

Economics and Statistics.

600. Asphalt and Related Bitumens. A. H. Redfield. U.S. Bur. Mines. Chapter (preprint) from *Minerals Yearbook*, 1941, Washington 1942.—It is reported in this summary that in 1941 the demand for asphaltic substances in the United States showed a marked increase over the previous year. Sales of rock asphalt increased by 43% in quantity and by 19% in total value. Producers' sales of gilsonite in Utah amounted to 36,407 tons valued at $851,623 in 1941 as compared with 31,930 tons valued at $770,711 in 1940.

23% more asphalt was produced at petroleum refineries in the United States in 1941, the greatest advance being made in the north-eastern quarter and the Mid-Continent area.

Stocks of petroleum asphalt at refineries were decreased by 10,000 tons during the period 31st December, 1940, to 31st December, 1941, although in Oklahoma, Kansas and Missouri, in the Rocky Mountain district, and in Texas, stocks at refineries increased.

Sales of petroleum asphalt by refineries to domestic consumers in the United States increased in quantity by 26% in 1941 as compared with 1940. Of the total quantity thus sold in 1941, 64% was used in the form of paving asphalt, paving flux, cut-back asphalts, and asphalt emulsions, for highway and street construction and for surfacing aerodrome runways. 25% of sales to domestic consumers was used for roofing purposes, and although shipments of prepared roofing increased by 29%, domestic sales of roofing asphalt and flux combined increased from 1,218,695 tons in 1940 to 1,671,696 tons in 1941.

In 1941, 8,831,000 brl. road oil were sold by refineries to domestic consumers, representing an increase of 5% over the figure for 1940. H. B. M.

601. Carbon Black. G. R. Hopkins and H. Bakus. U.S. Bur. Mines. Chapter (preprint) from *Minerals Yearbook*, 1941, Washington, 1942.—It is reported that during the year 1941 there was an increase in both production and sales of carbon black in the United States and that new records were established. Although exports continued to decline as a result of the war, domestic sales showed a sharp advance. Also by the time the rubber shortage began to affect the market other defence industries were demanding more carbon black, with the result that producers stocks decreased by 30% during the year.

480,212,000 lb. of carbon black were produced in Texas during 1941, representing 81% of the total output in the United States during the year. Louisiana produced 78,050,000 lb., as compared with 55,610,000 lb. in 1940. Kansas and Oklahoma together produced 35,803,000 lb. in 1941 compared with 33,287,000 in the previous year.

Carbon black is still most commonly produced by the channel process, but in this report it is noted that other processes, in particular Lewis, roller, "special" and thermatomic, are gaining in importance.

Statistics obtained from producers indicate that domestic sales in 1941 were

apportioned as follows: 439,502,000 lb. to rubber companies; 28,198,000 lb. to ink companies; 5,840,000 lb. to paint companies and 58,469,000 lb. to miscellaneous purposes (including 3 months' exports).

The average value of carbon black at the plants rose from 2·90 cents per lb. in 1940 to 3·26 cents in 1941. H. B. M.

602. Natural Gas. F. S. Lott and G. R. Hopkins. U.S. Bur. Mines. Chapter (preprint) from *Minerals Yearbook*, 1941, Washington, 1942.—Policy in the natural gas industry in the United States during 1941 was governed by the following factors: gas supply for expanding markets, particularly in the Appalachian region; transport facilities to consuming centres; availability of materials and equipment; measures necessary to protect installations from possible damage by sabotage or enemy attack. At the outbreak of war on 7th December, 1941, it was fully realized that natural gas must aid war production without hindrance, despite increasing difficulties.

Statistics given in this report show that marketed production of natural gas amounted to the new high level of 2770 billion cubic ft., or 4% more than in 1940. The gain in demand was mostly from industrial consumers, notably miscellaneous industrials (18%) and portland-cement plants (29%).

Prior to 1941 the average value of natural gas at the producing wells showed a persistent decline. In this year, however, it increased to 4·7 cents per thousand cubic ft. Reported completions (2·911) of gas wells in 1941 were 22% greater than the 1940 total. During the period under review there were rapid developments in the use of natural gas and its liquefied gases as constituents in the production of essential chemicals. It is forecast that many well-known substances which have long been made from other source materials—*e.g.*, ammonia, ammonium nitrate, acetylene, and alcohols—will be produced in quantity by processing the lighter hydrocarbons associated with petroleum.

In addition, many new compounds have been produced including explosives prepared by the nitration of methane and synthesis of nitro-hydroxy compounds.
H. B. M.

603. Natural Gasoline and Liquefied Petroleum Gases. F. S. Lott and A. T. Coumbe. U.S. Bur Mines. Chapter (preprint) from *Minerals Yearbook*, 1941, Washington, 1942.—1941 was the second successive year in which production of natural gasoline in the United States showed a sharp increase, and it is asserted that this was in fact the most profitable to the industry of any recent years. The gain in production over 1940 exceeded 15%, and daily outputs during 1941 increased consistently from 6·7 million gallons in the first quarter to over 8·2 million gallons in the last quarter.

Owing to war conditions the demand for natural gasoline increased by over 20%, and production was inadequate to meet this new demand. Thus 60 million gallons had to be withdrawn from storage in 1941. In 1940, 54 million gallons were added to stocks.

The proportion of natural gasoline used at refineries in motor fuel during 1941 increased to 7·1%, after remaining at the comparatively low level of 6·6% in 1939 and 1940.

Cycling operations in Texas increased at a slower rate in 1941 than in 1940. The number of cycling and repressuring plants reporting to the Railroad Commission of Texas increased from 32 to 45. In Louisiana the largest cycling plant in the world began operating in July 1941, in the Cotton Valley Field, Webster Parish, and in December a second large plant was started at South Kennings, Jefferson Davis Parish.

Natural gasoline production by compression plants continued to increase rapidly because of the cycling operations in Texas. Production by the absorption process expanded moderately in all the important producing States except California and Oklahoma, where failing gas supplies restricted the throughput in certain important fields.

Increased demand for suitable components for blending into 100-octane aviation gasoline stimulated development of "super-fractionation" technique, thus facilitating isolation of such lighter-end hydrocarbons as *iso*butance and *iso*pentane in relatively pure form.

48% more liquefied petroleum gases were sold in 1941 than in 1940, and it is believed

that the volume of deliveries to consumers in 1941 would have been even greater had equipment for handling and utilizing such gases been more freely available and had diversions for consumption as raw material in the manufacture of high-octane gasoline and other products been less exacting. The phenomenal increase in demand for this fuel is best realized when it is noted that in 5 years annual sales have quadrupled; moreover, in 1941 the total for each of the several gases under review, except pentane, is higher than the combined total for all liquefied gases reported as recently as 1936.

H. B. M.

PUBLICATIONS RECEIVED.

Géologie et Richesses Minerales de la region d'Erzincan (Turkie). By Dr. V. Stchepinsky. Institut d'Etudes et de Recherches Minières de Turquie.

Etude Paleontologique de quelques gisements du Lias d'Anatolie. By Dr. Galib Otkun. Institut d'Etudes et de Recherches Minières de Turquie.

Contribution a l'étude de la faune cretacee de la Turquie. By Dr. V. Stchepinsky. Institut d'Etudes et de Recherches Minières de Turkie.

Le dispositif géologique du secteur petrolifère du Bassin de Boyabat. By Maurice M. Blumenthal. Institut d'Etudes et de Recherches Minières de Turquie.

The Petroleum Industry : a selected list of recent references. The Library of Congress, Division of Bibliography, Washington.

British Standard Handbook No. 2.—Workshop Practice. Pp. 464. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 7*s.* 6*d.* net.

In this volume are gathered together the essential technical data from the many British Standards applicable to engineering workshops, so that every engineer concerned with design or manufacture may have by him the latest British Standard practice. There has been some rearrangement in a few of the specifications, but the essential text and tables have not been modified.

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Geology and Development.

604.* Recent Developments in Formation Logging. L. C. Uren. *Petrol. Engr*, February 1943, **14** (5), 63.—For a long time there has been an interest in the rate of penetration in drilling, and several automatic and semi-automatic drilling-time recording instruments have been developed. The rate of penetration depends on lithology, the type and condition of the bit, the pressure on the bit, the rate of rotation of the drill, the skill of the driller who feeds the drilling, and on the rate of mud circulation in the case of soft beds. In spite of the number of factors involved, the character of the formation appears to be the dominant factor controlling the rate of penetration. The rate of penetration log often compares closely with the self-potential log of the same interval, doubtless due to the relation of both logs to formation porosity and permeability. Correlation is possible by means of drilling time records, and the records may also be used in investigating bit performance and the effects of varying the drilling control conditions.

The diameter of the well tends to be larger where the formations are soft than where they are hard, thus caliper logs giving the variation in diameter of the well provide indications of the lithology. These logs also give data of value in cementing, gravel-packing, and packer installation. Fair accuracy in correlating formations is obtainable by means of caliper logs, and places which are favourable for using side-wall coring apparatus may be selected. G. D. H.

605.* New Field Indicated in Alberta, Canada. Anon. *Oil Wkly*, 15.3.43, **109** (2), 46.—Near Vauxhall, 20 ml. north-east of Taber, an important oil showing has been found in a well. About 1400 ft. of oil is standing in the hole, but the well's possibilities cannot be estimated until it has been shot and acidized. G. D. H.

606.* Wildcat Work Continues Active in Colombia. Anon. *Oil Wkly*, 15.3.43, **109** (2), 46.—The production decline in Colombia is due not only to loss of markets, but also to drilling up of the established producing areas at Infantas, La Cira, and Petrolea. Geophysical work continued in 1942, and some of the wildcats in the Magdalena valley and on the Barco concession, were encouraging.

In 1942 Colombia produced only about 10,600,000 brl. of oil, compared with 24,400,000 brl. in 1941. G. D. H.

607.* Large Bitumen Deposits Reported in Turkey. Anon. *Oil Wkly*, 15.3.43, **109** (2), 47.—Several large bituminous deposits have been found in Turkey. The Izmit deposits are reported to amount to 30,000,000 tons, those at Manisa to 15,000,000 tons, and those at Bolu to 7,000,000 tons. The bitumen content runs as high as 11%. On treatment the Izmit bitumen yielded 10% of gasoline, 14% of kerosine, and 12% of paraffin wax. G. D. H.

608.* Small Recovery Reported in New Zealand Drilling. Anon. *Oil Wkly*, 15.3.43, **109** (2), 47.—Extensive geological and geophysical work, supplemented by some deep drilling, has failed so far to establish commercial oil production in New Zealand. Three wells at Taranaki gave 93,915 gal. in 1941. G. D. H.

609. Oil Zones of the United States : Cambrian and Lower Ordovician. Anon. *Oil Gas J.*, 18.3.43, **41** (45), 68-A.—The principal oil and gas pays of Lower Ordovician or greater age are the Simpson dolomites and sandstones, the Arbuckle and Ellenburger limestones, Cambrian sandstones, and basal sands, conglomerates, and weathered pre-Cambrian rocks.

The pre-Cambrian reservoirs of the Texas Panhandle are supposed to have obtained their oil from the abutting Permian rocks, and in Western Kansas, Southern Oklahoma, and Pecos County, Texas, the oil-bearing granite, granite wash, or residual soil is overlain by Cambrian and/or Lower Ordovician rocks.

Cambrian sandstone production is relatively rare, being found in Kansas (mainly in Russell County) and Texas (Pecos County). It is possible that more oil may be found where the cover of Ordovician is thicker. The Arbuckle is the most important producing horizon of Western Kansas, and the Ellenburger is increasing in importance in North and West Texas, suggesting a 600–700-ml.-wide belt of potential pay running north-east from West Texas. Erosion prior to deposition of the overlying Simpson has provided porous reservoir zones near the top of the limestone. In the Ozarks there are several unconformities in the limestone suggesting the possibility of several pays deep in the limestone.

Simpson sandstones are important pays in Oklahoma (Seminole district, Nemaha ridge, etc.) and the Red River area and Pecos County of Texas. The Simpson dolomites give a little oil in the Seminole and Oklahoma City areas.

Beds roughly equivalent to the Simpson have shown signs of production in Illinois. An equivalent of the Arbuckle may prove productive in Kentucky. In the east and coastal areas the Cambrian–Lower Ordovician is too deep or too altered to yield oil.

A map shows the producing, favourable, and unfavourable areas for Cambrian and Lower Ordovician beds. G. D. H.

610. Well Completions Show Further Decline in February. Anon. *Oil Gas J.*, 18.3.43, **41** (45), 103.—1110 wells were completed in U.S. in February, as compared with 1221 in January. The dry holes numbered 349, against 417 in January, indicating a marked decline in wildcatting, which may be partly due to weather conditions. 638 oil-wells were completed in February, whereas there were 687 in January, pointing to a lack of locations in newly discovered and undeveloped fields.

A table summarizes operations in February by States and districts, with the total completions, numbers of oil, gas, and dry wells, the footage, and the well distributions in various depth ranges, together with the number of wells under way at the end of February. G. D. H.

611.* West Texas' Day Is Coming. Anon. *Oil Wkly*, 22.3.43, **109** (3), 11.—West Texas has prospects of deeper pays and new fields, and its current producing rate is capable of being increased quickly, although its location has been the cause of drastic production curtailment to 100,000 brl./day below its pre-war output. Its production can be increased by 200,000–250,000 brl./day from developed leases, and maintained at this rate for a year or more. Texas is likely to produce most of the 400,000 brl./day additional oil which will be required at the end of this year.

New pipe-lines to the east mean that Texas can expect steadily increased transportation facilities.

In January 1942 West Texas gave 300,000 brl./day from 13,136 wells. In January 1943 the output was only 200,000 brl./day, due to the curtailed allowable, and so West Texas has unused pipe-line allowables totalling nearly 15,000 brl./day, although all of this could not be used for deliveries to the Gulf Coast area.

The construction of a pipe-line from West Texas to the West Coast has been suggested, for it is doubtful whether California can sustain its present output of 775,000 brl./day without additional drilling and the discovery of new fields.

Many West Texas wells will need rehabilitation, for wells with uneconomically low allowables have not been kept in good condition. Owners with properties capable of large increases in production do not view large production increases with favour because of taxation.

A table gives the number of wells, monthly allowable, monthly production, monthly production per well, pipe-line runs in month, and storage at end of month for various dates since the beginning of 1941. G. D. H.

612.* Too Few Wildcats Completed in February but Oil Finding Results Fair. Anon. *Oil Wkly*, 22.3.43, **109** (3), 13.—During February the wildcat drilling was at two-thirds only of the rate necessary to give the 4500 wildcats sought by the Petroleum Administrator for 1943. Nevertheless the results came close to fulfilling hopes, since there were two above-average discoveries. It is possible that as much as 100,000,000 brl. of reserves were found and made available for development in U.S. through February discoveries, although conservative estimates might limit the figure to 50,000,000 brl.

461 wildcats were completed in January and February 1943, 68 being productive, against 87 producing wells out of 477 wildcats in the same period of 1942. The1943 discoveries included 51 new oil-fields, eight new oil-pays, and eight new gas-fields. This year there has been increased wildcatting in California, Kansas, Michigan, New Mexico, and Oklahoma, but decreased wildcatting in Illinois, Louisiana, Mississippi, and Texas.

In February 1943 a new oil-field and a new pay have been found in California. The Eocene shore-line accumulation at Guijarral Hills may have a reserve of 25,000,000–50,000,000 barrels, and may cover 400 acres. The new pay was found at Del Valle is at 7900–7975 ft. and 7990–8065 ft. The new Russell field of West Texas is about 4½ ml. south-west of Wasson. The oil is in a thick section of broken lime on an anticlinal structure. The remaining February discoveries have reserves under a few million barrels each, according to present indications.

Tables set out by States details of the wildcat completions in February 1943 and January–February 1943; the trend of wildcat completions; the name, location, dates of spudding and completion, depth, completion horizon, age and character of the producing formation, oil gravity, type of structure, method of discovery, and a preliminary estimate of the reserves for the oil and gas discoveries of February.

G. D. H.

613.* Inspection and Analysis of Formation Samples. L. C. Uren. *Petrol. Engr*, April 1943, **14** (7), 72.—Formation samples may be bailer samples, bit samples, chip samples, cable-tool cores, mud-flush samples, rotary cores, wire-line cores, side-wall cores, diamond drill cores, side-wall samples, and pressure-type cores. Each has its own inherent advantages and disadvantages. Bailer and bit samples are of rather uncertain value, and the same is true of mud-flush samples. Side-wall cores can be taken from points which the drill has passed, and are small, but dependable. Diamond drill cores are the most dependable cores, and give a very large percentage recovery. Pressure-core barrels give samples which can be brought to the surface without reduction of pressure or loss of fluids.

Excess bit pressure in coring may crush and shear the core, and in certain circumstances cause fusion of some minerals. In rotary drilling the drilling fluid may be driven into the core, and surface-tension effects may also lead to displacement of oil from the outer part of the cores. Release of pressure in bringing the core to the surface may result in "bleeding." The oil content of a recovered core may be regarded as a minimum.

At the surface the core should be removed from the barrel as soon as possible, the clay sheath scraped or washed off carefully, and the core fragments arranged correctly in suitable trays on which the top and bottom of the cored interval are marked, and with spacing blocks for obvious gaps.

The fluid content of the core should be noted, with a test for oil. The positions of partings are recorded, together with such features as fault planes, joints, cross-bedding, solution cavities, etc., the dip, and type of lithology. Representative samples are selected for laboratory examination, protected from loss of fluids in transport, and carefully labelled.

At the laboratory the samples are again inspected, and any loss of fluid is noted. A portion of each sample is taken for fluid-content determinations, and a second portion for permeability measurements. Permeability may be measured parallel to and perpendicular to the bedding, generally on carefully prepared cylindrical specimens from which all fluids are removed in a Soxhlet extraction apparatus. G. D. H.

614. Large Reserve Decline Shown by Allocations to Discovery Year. W. V. Howard. *Oil Gas J.*, 1.4.43, **41** (47), 14.—In 1942, 1,760,884,000 brl. of oil were estimated to

have been added to the U.S. proven reserves. Of this 919,496,000 brl. were added by revision of estimates of oil in older fields. Extensions to older fields added 515,580,000 brl., and discoveries of new sands and new fields added only 322,808,000 brl., 58,108,000 brl. being attributed to new sands.

The allocation of all the recoverable oil in a field to the year of discovery shows the trend of discoveries more clearly than does the inventory method.

During the 1920's production rose so rapidly that despite large discoveries the ratio of reserves to annual production declined steadily from about 23 to under 15. The discovery of East Texas in 1930 and Conroe, K.M.A., Silica, and Trapp in 1931, together with declining demand, raised the ratio of reserves to annual production to more than 26.

Prospecting increased in 1934 after a period of depression, and a series of important discoveries followed until the reserves totalled nearly 24,000,000,000 brl. in 1938, since when they have declined, for production has exceeded discoveries by nearly 3,000,000,000 brl.

Reserve and production and discovery data are tabulated by years since 1895, and curves show the reserves at the end of each year, the production and discoveries in each year, the ratio of reserves to production, and the price per brl. over a similar period. G. D. H.

615. Rich Oil Sand Discovered with Condensate at Katy Field. Anon. *Oil Gas J.*, 1.4.43, **41** (47), 17.—A good oil-sand has now been found in the big Katy gas-distillate area of Waller and Harris Counties, Texas. The oil-discovery well, 2¼ ml. from the nearest Katy gas production, gave 153 brl. of oil in a day from 6622 to 6625 ft. The well found gas and distillate in three sands at 7338–7345 ft., 7116–7121 ft., and 6847–6851 ft., each of these sands having a considerable gas output potential. While the oil may merely be a pocket, it is generally believed to represent a new and important oil-pool. The oil-sand may skirt the perimeter of the Katy field, or may be co-extensive with gas-condensate sands of the field, which now has 23 wells. G. D. H.

616.* Problem of Exploration during the War. E. De Golyer. *Oil Wkly*, 5.4.43, **109** (5), 39.—The U.S. oil requirements in 1942 were about 1,400,000,000 brl., 1% more than in the preceding year, despite restrictions. Conservative estimates indicate that 1,500,000,000–1,600,000,000 brl./yr. will be needed during the next two or three years. At the beginning of the war the reserves were about 20,000,000,000 brl., but the prospect of increasing demand when the rate of discovering new reserves is low is disturbing. The unused 300,000–400,000 brl./day productive capacity of the Permian Basin represents oil which is not especially suitable for use at present, and oil which is not readily transportable to the required points. Since 1938 the reserves discovered in new fields annually have been less than the yearly production, the average figures being respectively 640,000,000 brl./yr. and 1,380,000,000 brl./yr. The unsatisfactory exploratory results are not due to reduced exploratory effort, for since 1939 over 3000 wildcats have been drilled each year, and more than 300 geophysical and core-drill crews were employed throughout 1942. In the 1939–1942 four-year period the average number of new fields found each year was 215, compared with an average of 130 for the preceding four years. During the 1939–1942 period the average new oil discovered per field was 3·2 million barrels, against an average of 15·6 million barrels/field in the preceding four-year period. In 1942 the average size was estimated to be 1·2 million barrels.

The present first-rate prospects are said to be comparable to the second- and third-rate prospects of the middle thirties.

Various techniques have successively shown peaks as regards the number of discoveries made. Past exploration has been concerned chiefly with structural traps, and the sizes of the structures now being found make it clear that the search for stratigraphic traps must be intensified. The search for stratigraphic traps will call for many more wildcats. All available geological information should be carefully studied before drilling these wildcats, and core tests may be necessary.

An adequate exploration programme will require more materials, more man-power, and greater expenditure. The supply of materials should not prove too difficult, but increased man-power requirements are a more serious problem, for the type of man required is also sorely needed by the armed forces. G. D. H.

617.* New Oil Reserves Must be Found. A. Duessen. *Oil Wkly*, 5.4.43, **109** (5), 47.—If the war demand for oil continues to accelerate there will probably be a shortage by the end of 1943, with the possibility of a serious situation in 1944 and 1945 if the war continues, for the discovery rate is not keeping pace with the production. Last year, according to A.P.I. estimates, the oil discovered in new fields amounted to 260,054,000 brl., while the production was 1,385,479,000 brl. However, the revision of reserves from year to year is more important in adding to the inventory at the year end than the amount of new oil actually assigned to wells in new fields. In spite of the possibilities in this revision, the 1942 discoveries are not reassuring.

The effectiveness of geophysics as an impetus to discovery seems to have reached its limit. Wildcatting must be stimulated, for even dry wildcats may give information which leads to discoveries later. The use of geophysics and the increasing cost of wildcats in recent years have tended to make wildcatting a major company operation. In the past wildcat operators with little capital have taken risks and found much oil, and it is necessary to encourage such operators to continue, since much oil will come from the type of random drilling which they carry out. An intense wildcat campaign is now needed in Texas and Louisiana, the most promising areas for new oil, with considerable activity in Kansas and California, and to some extent in Mississippi, Alabama, and Florida also.

An increase in the price of oil is urgently needed if the present reserve situation is to be corrected at any time in the near future. In the last World War there was a similar critical situation, but the price of crude was allowed to rise to $3 per barrel, and so at the end of the war and shortly after there was an over-abundant supply.

Americans must also be encouraged to develop the oil reserves of Mexico and South America, in order to have a nearby oil source when the U.S. domestic supply fails. It is probable that American ingenuity will be needed to discover these reserves.

G. D. H.

618.* Wildcat Drilling and Discovery Rates in 1942. F. H. Lahee. *Oil Wkly*, 5.4.43, **109** (5), 57.—See Abstract No. 621.

619. A Survey of the Nation's Oil Reserves and Needs. W. B. Heroy. *Oil Gas J.*, 8.4.43, **41** (48), 34.—The first estimate of the recoverable oil in the known U.S. fields was made in 1908, and from then until 1927 the estimates of remaining reserves increased at a moderate rate to about 5,000,000,000 brl. During the next decade the reserve estimates rose to over 12,000,000,000 brl. From 1937 to 1939 the rate of increase reached its maximum, and the total rose to about 18,500,000,000 brl. During the last three years the rate of increase has fallen, so that the reserve estimate now stands at a little over 20,000,000,000 brl.

The reserves attributed to newly discovered fields have shown a downward trend since 1937, but it must be noted that the annual reserve increases due to extensions and revisions are three to five times as large as the increases shown as resulting from new discoveries. In 1937 the initial estimate of newly discovered oil was the highest ever at 929,000,000 brl.; in 1942 the initial estimate was only 260,000,000 brl. Practically all the increases in reserves, and especially those resulting from new discoveries during the past few years, have been in the south-west, in Texas and Louisiana, the reserves of these two States having risen by over 2,000,000,000 brl. in two years.

Of the 400,000 U.S. producing wells about 12% flow, and about 15% are capable of good yields in spite of being on artificial lift. The remaining 73% are stripper wells yielding only 15% of the total production. 40% of Texas' wells flow, 10% of California's and 34% of Louisiana's, the three States possessing over 90% of the country's flowing wells. As a whole the oil-fields have a normal annual decline of 400,000 brl./day in productive capacity, calling for new fields and wells in order to maintain the productive capacity. Since 1937 the initial oil production from new development has declined seriously from 24,222,121 brl./day to 2,841,300 brl./day, and from 1077 brl./well/day to 259 brl./well/day.

G. D. H.

620. Discovery Thinking. A. I. Levorsen. *Oil Gas J.*, 8.4.43, **41** (48), 38.—If the same rate of increase in production continues in the next twenty years in U.S.A.

as has held in the past twenty years, and if the discovered reserve is to be thirteen to fourteen times the annual production, it will be necessary to discover 50,000,000,000 brl. of new oil—a greater amount than has been discovered since the beginning of the oil industry. Although much oil has been found by random drilling, and much will be found in that way in the future, the only rational way of making available the undiscovered reserves is by the application of scientific methods and reasoning.

The present decline in discovery rate may be due to approaching exhaustion of ultimate reserves or to insufficient discovery effort. Most of the effort is being expended on searching for extensions, for deeper sands, and in working and re-working progressively smaller areas in developed provinces. Attention must be directed to new oil provinces. Many oil provinces are associated with the up-dip wedging out of reservoir porosity. These wedge-belts include the Oriskany and other Devonian and Mississippian sands in the Appalachian area; the Clinton sand and Trenton lime pays of Ohio; "Corniferous" production flanking the Cincinnati arch; Chester production in Illinois; Cromwell and Wilcox production in the Seminole area, and Simpson, Bartlesville, and Burbank production in north-east Oklahoma; Pennsylvanian sands in North Texas and the Laredo district; the reef and sand belts of the Permian Basin; the Etchegoin of the Midway–Sunset province; the Eocene and Miocene of the Coalinga area and much of the east side production of the San Joaquin Valley. There are thousands of miles of buried up-dip wedge belts of porosity in rocks known to produce elsewhere, and yet which are only partly explored to-day, or completely unexplored. A wedge-belt is a clue to a province, whereas a local fold is a clue to a pool. Much of the evidence of the existence of these wedges is already known.

Each set of beds separated by an unconformity is independent of the underlying and overlying unconformably separated beds and has its own oil and gas geology. No area can be considered as completely explored until many wells have been drilled through all the layers of geology down to the basement rocks, and every sedimentary region of the U.S. has unknown and unexplored geology waiting to be drilled. Each layer has its own wedge-belts of porosity, its own lithological changes, and its own structural history.

The only way of reducing the above conditions to practical application is by the preparation and study of facies maps, lithological maps, isopachyte maps, palæogeographic maps, palæogeological maps, quantitative and qualitative sedimentation studies, and detailed stratigraphic analysis of all the porous sediments. Much will be a matter of restudying data and material already possessed by the oil companies. Broadly trained and speculatively minded geologists will be required for this work.

Many pools produce from limestone reefs or reef-like deposits, suggesting that many similar pools remain to be found. Pools are still being found by surface mapping, while others are being found by careful re-study of areas in the light of more up-to-date information.

Extensive fundamental research is needed in petroleum geology. G. D. H.

621. Wildcat Drilling in 1942. F. H. Lahee. *Oil Gas J.*, 8.4.43, **41** (48), 40. During 1942 3219 wildcats were drilled, with a total footage of 12,172,851 ft., and the 493 producers accounted for 10,007,066 ft. In the southern States district 6,633,895 ft. were drilled in 1424 holes, of which 232 were producers with a total footage of 1,296,558 ft.

Assessing the reasons for drilling the wildcats shows that 460 drilled on geological or geophysical advice were successful and 587 dry. Twelve producers and 80 dry holes were located for reasons unknown. Thus the percentage success for technical locations was 4·9.

During 1942 wildcat drilling was above the 1941 level in California (163 to 124), Kansas (330 to 267), Mississippi (60 to 52), Oklahoma (254 to 246). During 1942 there were fewer wildcats than in 1941 in Illinois (549 to 591), Louisiana (189 to 202), Michigan (216 to 231), and Texas (1076 to 1210). Except in California, the average wildcat depth was greater in 1942 than in 1941. The degree of success of technically located wildcats as compared with those located non-technically was 3 in 1937, 2·2–3·2 in 1938, 1·5–2·2 in 1939, 3·7 in 1940, 5 in 1941, and 3·7 in 1942.

109 out of 566 wildcats located in 1942 on the results of seismic work were successful,

and a further 52 out of 163 located on a combination of seismic and geological data were successful.

Analysis of data for Arkansas, California, Illinois, Indiana, Kansas, Lousiana, Michigan, Mississippi, New Mexico, Oklahoma, and Texas, which possess 95% of the proved U.S. oil reserves, indicates a marked drop in the rate of discovery since 1937, in spite of increasing numbers of wildcats, except in 1942. In 1937 109·4 brl. of new reserves were discovered per foot of wildcat drilling, but only 21·7 brl./ft. in 1942. The decline in success is due to the increased difficulty of finding the new geological traps because they are fewer, deeper, and associated with less pronounced geological structure and sands of lower permeability.

A series of tables and diagrams give details about wildcat drilling. G. D. H.

622. Some Factors Influencing Declining Rate of Crude-Oil Discoveries. L. F. McCollum. *Oil Gas J.*, 8.4.43, **41** (48), 41.—Recent P.A.W. estimates of U.S. crude-oil needs in 1943 are slightly under 4,000,000 brl./day, with a peak of perhaps 4,200,000–4,600,000 brl./day late in the year. In 1942 375,000,000 brl. of oil were discovered in the Mid-Continent–Rocky Mountain–Gulf Coast areas, in 1941 655,000,000 brl., and in 1940 1,185,000,000 brl. There has been a decline in the average size of discoveries since 1930, and apart from the slump period of 1931–1933 the number of discoveries has risen continuously since 1900. Shortage of materials and spacing regulations may be responsible for the decline in total completions in this area from 23,148 in 1941 to 12,929 in 1942. The wildcat completions fell from 3255 in 1941 to 2956 in 1942.

The petroleum industry has lost about 15% of its personnel to the armed forces, and the loss of geophysical personnel may be 30%.

During the past few years there has been a lack of correlation between the number of dry holes drilled, the discoveries, and the price of crude oil. The decline in discoveries is probably due neither to material shortage, man-power shortage, nor to price. Examination of the discovery rate in the Mid-Continent–Rocky Mountain–Gulf Coast region shows the importance that new prospecting territories and new exploration methods have played in maintaining the discovery rate. It appears that without the opening of new prospecting territory discovery rates in the past 40 years could not have been maintained. It is clear that there has been a rapid increase in the amount of oil discovered soon after the inception of each new method, and each method is now in a period of lessened effectiveness. The above two factors have been the major causes of the decline in the discovery rate during the past few years.

Exploration in new regions and with new methods may increase costs. The search for new finding tools must be intensified. G. D. H.

623. Maintaining an Adequate Level of Geophysical Exploration. F. Goldstone. *Oil Gas J.*, 8.4.43, **41** (48), 56.—Published estimates suggest that the U.S. yearly discovery rate of new oil has been declining for the past five years at least, and some time in the recent past consumption exceeded the finding rate of ultimately recoverable oil in new fields for the first time. It is necessary to discover new fields, and the exploration programme must be planned so that it will be virtually certain to attain the minimum objective without precluding the spectacular results which have frequently rewarded those willing to take the maximum risks. In most areas geophysics offers the best means of reducing structural uncertainties.

In 1942, 225 seismograph crews and 50 gravity crews were operating, and most of these were in areas of proved production; there was little exploration in present unproductive areas. But in spite of great activity, discoveries failed to equal withdrawals. In order to try to overcome this failure existing geophysical technique must be applied with greater precision in well-explored productive territory to detect even the smallest promising geological features, and such a tendency is already evident in the increased number of small fields discovered. The cost of discovery will probably rise to thirty cents per barrel.

Proved methods must be applied in new territories. Attempts must be made to discover methods which can be applied in areas where drilling only awaits adequate structural guidance, but where the existing geophysical methods have so far been incapable of giving such guidance.

No policy involving less effort than in 1942 offers reasonable assurance of maintaining the discovery rate of new fields. The 4500 wildcats recommended for 1943 should ensure the testing of virtually all the structural prospects and many stratigraphic traps, with sufficient wells left to follow up exploration in new areas.

About 40% of the technically trained geophysics staff has been lost to the forces and war-work, and further losses will involve the cutting down of field crews. Supplies are a less serious problem than man-power. G. D. H.

624. Oil Zones of the United States; Middle Ordovician to Devonian. Anon. *Oil Gas J.*, 8.4.43, **41** (48), 88 B).—The Trenton limestone of Ohio and Illinois and the Viola limestone of Oklahoma and Kansas are of Middle Ordovician age, the former giving most oil on the northern part of the Cincinnati Arch, and the latter most oil north and south of the Wichita–Arbuckle uplift and round the south flank of the Central Kansas uplift. The Medina (Lower Silurian) sandstone provides much gas in New York and Ohio. The Lower Devonian Oriskany sandstones yield much gas and a little oil, and deeper in the Appalachian Basin the sandstones of the Chemung and Catskill (Upper Devonian) have given much oil, but over a large part of the area they are replaced by thin sands and thick shales. The bulk of Michigan's production comes from the Traverse, Dundee, and Monroe limestones of the Lower and Middle Devonian. In Central Kentucky the "Corniferous" is the principal pay, formerly being thought to be of Onondaga age. Some of the pay section is in the Niagaran (Middle Silurian), the equivalent of which is the productive Hunton of Oklahoma. Good Devonian production is found round the margin of the Illinois Basin. Recently Silurian limestone oil production has been found in Ward County, Texas.

Uplifts during the late Ordovician continuing through the Devonian either prevented the deposition of Middle Ordovician to Devonian beds over them, or else permitted their erosion if such beds were deposited. Hence there is little chance of finding commercial oil accumulations in these pays over the Bend Arch and the West Texas highs. Extensions of Viola production and the introduction of Devonian pays may be found to the north-west of the Eastern Kansas producing area, and in the basins of Kansas and Oklahoma. In the Rocky Mountain States the Jefferson limestone of Devonian age has shown some oil, though not yet in commercial quantities. G. D. H.

625. Fell Cites Figures Showing How Low Price Subdues Exploration. Anon. *Oil Gas J.*, 22.4.43, **41** (48), 32.—Curves show a sympathetic relationship between the current price per barrel of crude oil and the number of wells drilled, but it takes one to two years for the increase in price to give a considerable increase in the number of producing wells.

Drilling contractors are now charging 75 cents to $1/ft. more than a year ago, and the cost of moving to a new location has been trebled.

In Kansas it is suggested that an increase in price of at least 50 cents/brl. is necessary if wildcatting is to be maintained. There 352 wells were completed in the first quarter of 1943, 174 being oil-wells and 7 gas-wells. 94 were wildcats, of which 15 were producers which may have averaged $30,000 per well, while the failures were $15,000 per well. If the wildcat producers drain 40 acres each with a recovery of 4000 brl./acre, the expected 2,400,000 brl. will have caused the spending of $1,535,000 on wildcatting, and therefore the cost of discovery is 63·9 cents/brl. If lifting costs are 30 cents/brl., royalties, rentals, and bonuses 35 cents/brl., the total costs excluding taxes and salaries is $1·29/brl., against a crude selling price of $1·17/brl. G. D. H.

626. Western Kentucky Offers Opportunity for Prospecting. H. H. Nowlan. *Oil Gas J.*, 22.4.43, **41** (50), 90.—There seems to be plenty of space in Illinois, Indiana, and Kentucky for a large number of wildcat plays, and whether the wells are successes or failures the information derived is of service in working out additional favourable wildcat plays.

Now Louden, Salem, Clay City, and other large pools in the Illinois Basin are declining, and knowledge of the basin is increasing as more wildcat tests are completed and as many small pools are being opened. Comparable conditions obtained in Oklahoma in the early 1920's, and were followed by an increase in wildcatting which brought increased discoveries and further large pools.

A year ago conditions were at a low point in Western Kentucky, when in August 1942 the Smith Mills pool, Henderson County, was opened. It now has 51 wells in the Cypress sand at a depth of 2300 ft., with initial outputs up to 1200 brl./day. The productive area may cover 1000 acres. Production is by water-drive from a blanket sand on a structure with at least 30 ft. of closure, and probably 60–80 ft. This pool has directed attention to an area of about 2500 sq. ml.

Production along the Wabash River is on an anticlinal nose in a graben. At the Barrett Hill pool and Sebree pool oil is in a fault zone on horsts. In other pools oil occurs under ordinary structural conditions, including numerous stratigraphic traps.

The important Rough Creek fault zone has most of its faults striking N.W.–S.E., with transverse N.E.–S.W. faults cutting these. The maximum throw is over 3000 ft. Electric logs for a series of wells on a line from Salem (Illinois) to Calvin, Mount Vernon (Indiana), Smith Mills (Kentucky), and Hopkins County show formations from the base of the Pottsville to the Ste. Genevieve. The base of the Pottsville lies on the eroded Chester in which there are seven productive sands in Illinois and Kentucky.

The most active area is now north of the Rough Creek fault zone, and the most important developments are the Smith Mills, Robards, Uniontown, and Wathen pools. The area south of the Rough Creek fault zone may be explored later in 1943. G. D. H.

627. March Completions Show Increase over February. Anon. *Oil Gas J.*, 22.4.43, **41** (43), 94.—1292 wells were completed in U.S.A. in March, 182 more than in February. 39 of the increased number of completions were in California, where there is considerable redrilling of old heavy oilfields. Oklahoma had 32 more completions than in February. As regards drilling depths, the greatest increase was in the 2500–5000 ft. range, which is a reflection not only of the location of the drillable spots, but also of current crude prices which tend to render deeper drilling unduly costly. 73 wells were less than 1000 ft. deep, 602 1000–2500 ft. deep, and 25 over 10,000 ft. deep.

A table gives by States the numbers, types, and footage of completions, together with the numbers in different depth ranges. G. D. H.

Geophysics.

628.* Limiting Values of Gravitational and Magnetic Anomalies Due to a Subterranean Structure Bounded by a Single Differential Surface. J. W. Fisher. *Geophys.*, 1941, **6** (1), 1–12.—The case of two layers is considered, each homogeneous in density and magnetic susceptibility, and the lower extending downwards to an infinite depth. It can be shown that, whatever the nature of the folding of the differential surface separating the two layers, there will be certain maximum possible values for the anomalies, and that these will depend solely on the assumed difference in density or susceptibility and on the greatest and least depths of the bounding surface. Accordingly, the following limiting values have been calculated for this case: (1) vertical gravitational anomaly; (2) first horizontal derivative of the vertical gravitational anomaly; (3) second horizontal derivative of the vertical gravitational anomaly; (4) horizontal directing tendency recorded by the Eötvös torsion balance; (5) vertical magnetic anomaly; (6) first horizontal derivative of the vertical magnetic anomaly perpendicular to the magnetic meridian and also parallel to the magnetic meridian; (7) second horizontal derivative of the vertical magnetic anomaly.

A knowledge of these theoretical maxima enables one, by comparison with the maximum observed values of the corresponding quantities, to fix certain limits to the depth of the bounding surface. S. E. C.

629.* The Gulf Gravimeter. R. D. Wyckoff. *Geophys.*, 1941, **6** (1), 13–33.—Recognition of the inherent limitations of the pendulum method of gravity survey led, in November, 1932, to the consideration at the Gulf laboratory of the problems of gravimeter design. To minimize delay, two types were investigated and constructed, the astatized and the unastatized. By the end of 1934 it was possible to make a choice between them, and the unastatized type was selected for development. This instrument, modified from time to time, has been used ever since, and it completely supplanted the pendulum equipment in 1936.

A gravimeter should be designed so that its probable error does not exceed 0·1 milligal, thus making the minimum sensitivity approximately 10^{-7} g. The difficulty with the unastatized type using a mass supported by a helical spring, is the measurement of the extremely minute displacements. The practical effect of astatization, on the other hand, is to render the system non-linear, with the result that each change in adjustment changes the sensitivity and scale value of the instrument.

An astatized gravimeter, constructed by modifying a Galitzin vertical seismograph, was used for determining the characteristics of springs, and another astatized instrument with bifilar suspension was built as a field instrument. No field tests were made, however, with these instruments.

The difficulty of measuring minute displacements in the unastatized type was overcome in a very simple manner. A ribbon helix is used for the spring, and this produces a rotation of about 1 second of arc per 10^{-7} change in g. The rotation of the suspended mass is observed by means of an attached mirror, so that there are no levers or other connections with the moving system. A special multiple reflection mirror arrangement permits reading the undeflected beam together with multiple reflections readable beyond the sixth. Using the fourth reflection and an optical lever 22 inches long, 0·1 milligal corresponds to a 0·001 inch displacement of the index under the micrometer microscope. The total range is 25–30 milligal, but the zero is readily adjustable by means of a torsion head without appreciable change in calibration constant.

The actual construction of this type of instrument, with which observations have been made at more than 200,000 stations since 1936, is described in some detail.

S. E. C.

630.* The Gulf Underwater Gravimeter. T. B. Pepper. *Geophys.*, 1941, **6** (1), 34–44.—Gravimeters require a firm support, a fact which makes work over water-covered areas difficult. The first attempt to overcome this problem was the utilization of tripods, which enabled observation to be made on calm days in water as deep as 18 feet. The equipment, however, was cumbersome and the method was slow and costly. It was therefore decided to design an instrument which would operate on the bottom and, after considering various schemes, work was started on a gravimeter contained in a pressure housing and with all controls, including levelling, operated by remote control from the surface. The design of this instrument is described in some detail. Photographic recording is used, and about 10 observations can be made on a standard film. In calm water the record can be read with an accuracy of about 0·02 milligal. At the time of writing the paper, a maximum of 17 stations per day had been taken, the average being 6.

S. E. C.

631.* The Effect of Density on Seismic Reflections. S. S. West. *Geophys.*, 1941, **6** (1), 45–51.—In seismic prospecting it is generally assumed that only velocity changes are significant, but it is pointed out here that density changes can be quite as important in producing seismic reflections. The empirical correlation of reflections with abrupt changes in the velocity-depth curve, therefore, may sometimes lead to serious errors. In order to illustrate this point, detailed data were obtained from 10 wells in New Mexico, and this was sufficient to permit the calculation of the true reflection coefficients and their comparison with reflection coefficients based on the assumption of equal densities. In 5 out of 6 cases the effect of change of density was such as to reduce the amplitude of the reflection so seriously as to make it scarcely detectable.

S. E. C.

632.* Resolution Control in Seismic Surveys. R. F. Beers. *Geophys.*, 1941, **6** (1), 52–63.—Seismic reflections originate in stratified media at discontinuities of density, modulus of elasticity, velocity of propagation of longitudinal waves, acoustic impedance, etc. It is therefore possible by means of direct measurement to obtain detailed information regarding the nature and properties of rocks encountered in the path of the seismic waves. The ability of the reflection seismograph to resolve these details is affected considerably by conditions at the shot-hole—depth, dimensions of the shot-hole cavity, and length of time during which the seismic impulse persists.

In making measurements it is customary to use measuring devices consistent with

the dimensions to be measured. In seismic work, therefore, the wave-length should be of the right magnitude, and this may be controlled by controlling the duration of the seismic impulse at the shot-point. For instance, in the East Texas Basin the length of this impulse can be varied between the limits of 0·02 and 0·04 second. The choice of length of impulse is governed by the characteristics of the geological section and the detail required. The shorter the impulse the more detail obtained, but in a section rich in reflecting horizons this may easily lead to confusion.

In this problem of resolution the influence of the recording instruments must also be considered. Control may be established at the point of generation of the impulse, but resolution may still be lacking, due to wrong instrument characteristics. The cases are discussed of instruments, both critically damped and undamped, which have natural periods longer than, equal to, and shorter than the period of the ground motion. S. E. C.

633.* A Numerical Method of Computing Dip Data Using Well-Velocity Information. K. H. Waters. *Gephys.*, 1941, **6** (1), 64–73.—Well-shooting data are used in a series of computations for the making of charts which, with a knowledge of the time and differential time of a reflection, will give the depth and position of the reflecting point and the angle and azimuth of dip. The velocity laws considered in these computations have the common characteristic that the velocity is the same at any point in a horizontal plane at a given depth. The method is applicable to steeply dipping strata. S. E. C.

634.* A Transformed Wave-Front Chart. R. A. Peterson. *Geophys.*, 1941, **6** (1), 74–80.—In the computation of the position of a seismic reflecting interface, a "wave front–wave path" chart may be constructed showing the position of the wave front for progressive intervals of time and of the wave path for various values of the angle of emergence. By this means it is possible to read the position of the reflecting interface directly from the chart, but the presence of four superimposed sets of closely spaced co-ordinates makes this a tiring process if much repeated. A transformation is described here whereby the co-ordinates representing wave fronts and wave paths are replaced on the chart by a mechanical arm pivoted at the shot-point and carrying a scale showing the wave-front position for progressive intervals of time. The sine of the angle of emergence is read on a circular scale over which the lower end of the arm passes. There are therefore only two sets of co-ordinates on the chart, and the fatigue in using it is considerably reduced. S. E. C.

635.* Application of the Fourier Integral to some Geophysical Problems. W. T. Born and J. M. Kendall. *Geophys.*, 1941, **6** (2), 105–115.—Fourier integral analysis is discussed, and a special type of Henrici rolling sphere harmonic analyzer for evaluating $\int F(x) . \sin ax\, dx$ and $\int F(x) . \cos ax\, dx$ is described. The use of this method for obtaining true ground motion freed from instrumental frequency and phase distortion is dealt with in some detail. It may also be applied to the prediction of instrument performance and the possible variations in the shape of a reflection pulse with instruments of different characteristics. S. E. C.

636.* The Effect of the Placement of a Seismometer on its Response Characteristics. H. Washburn and H. Wiley. *Geophys.*, 1941, **6** (2), 116–131.—Experience shows that it is often necessary to bury certain types of seismometers to obtain good results, a not very convenient arrangement when a large number is in use. Experimental work was carried out, therefore, to find the best conditions for a surface "plant," and the effect of the different surface conditions which are met in the field. The apparatus consisted of two seismometers of the dynamic type with small moving masses. The instruments were rigidly bolted together, one serving as a driver unit to impart motion to the seismometer and the ground, and the other serving as a detector of the resulting ground velocity. The experiments showed that the ground and the seismometer act as a resonant system, the characteristics of which are affected by a number of factors: size of base, weight, method of planting of the seismometer, and the condition of the ground surface. It is concluded that an instrument for field

work should be light in weight and with a base area which is a compromise between an area large enough to flatten the response appreciably and an area small enough to facilitate rapid operation. Numerous experiments were carried out with plants in different types of ground and at different seasons of the year. These indicate that when designing a seismometer the elastic constants of the ground must be taken into account and, if properly designed, it is possible to use surface plants in many areas. S. E. C.

637.* The Attenuation Constant of Earth Materials. W. T. Born. *Geophys.*, 1941, **6** (2), 132–148.—In theoretical work it is frequently assumed that the losses causing attenuation of waves are viscous in character. Since the surface rocks of the earth are solid, it is surprising that more attention has not been paid to the subject of solid friction, and experiments were therefore made to determine to what extent losses in small samples are viscous or are due to solid friction. A bar was cut from the rock sample, and a small coil of wire was cemented at each end; the bar was supported at its midpoint, and the coils were arranged to oscillate in a magnetic field. A variable frequency oscillator supplied current to one coil for driving the bar, and the resulting motion at the opposite end was detected by the other coil which acted as a pick-up. It was found that in dry samples the losses are of the solid friction type, but that when damp there are additional losses of a viscous character. These experimental results were obtained on relatively few, well-consolidated samples, and the extension of the findings to the crust generally is open to doubt, on account of the effects of depth of burial and the plasticity of unconsolidated sediments. It is shown, however, by a consideration of the relative amplitudes of the various reflections found on a seismograph record that the laboratory data are consistent with the values calculated for maximum total decrement. Curves showing the frequency characteristics can be plotted on the basis of this work, and these show that the earth acts as a low-pass filter. S. E. C.

638.* The Range of Amplitudes in Seismic Reflection Records. J. M. Kendall. *Geophys.*, 1941, **6** (2), 149–157.—The relative amplitudes of incoming waves are plotted as a function of time, examples being taken from six widely separated areas. Correction for divergence is made, and the amplitude of the recorded waves is then found to decrease exponentially with time. By exploding charges of various sizes in a shothole the relatively great increase in charge needed to produce even a small increase in usable length of record is demonstrated. S. E. C.

639.* Average Vertical Velocities from Refraction and Reflection Profiles. W. R. Ransome and F. Romberg. *Geophys.*, 1941, **6** (2), 158–167.—A combined refraction–reflection profile was shot in 1937 in the district of Infante, Guarico, Venezuela, on a location where elevations were extremely flat, weathering relatively uniform, and where the profile could be shot along the strike. Vertical velocities are calculated from the data so obtained. Two years after the completion of the survey it was possible to obtain vertical velocities direct from measurements made in a well drilled during the intervening period. The maximum difference between measured and calculated velocities is only 5%, and it is therefore suggested that, where well shooting is not possible, velocities can be obtained in the manner outlined in this paper. S. E. C.

640.* Network Adjustment by Least Squares—Alternative Formulation and Solution by Iteration. M. O. Gibson. *Geophys.*, 1941, **6** (2), 168–179.—If in any adjustment of a network comprising observed differences in values of adjacent points, (1) the sum of the corrected observations around any circuit is zero, and (2) the sum of the corrections at any junction is zero, then the corrections are least square corrections. On this basis it is shown how the adjustment of networks can be considerably simplified and, in many cases, the amount of work reduced, The principles may be applied also to electrical circuits. S. E. C.

641.* The Calculation of Gravity Anomalies Due to Bodies of Finite Extent. S. Levine. *Geophys.*, **6** (2), 180–196.—In contrast to the usual indirect procedure, where various mass distributions are tried until a calculated anomaly resembling field results is

obtained, direct methods of interpretation have been developed, as, for example, by Jung and by Schwinner and Ansel. The latter divide geological bodies into a group of tabulæ, and then derive formulæ for calculating their gravitational anomalies. This process, for bodies of finite extent, is cumbersome. A graphical method has therefore been developed in which curves are drawn representing the boundaries of the body, the area enclosed by them being a measure of the gravitational effect of that body. This area can be measured with a planimeter. The rapidity of the method is emphasized. S. E. Cr

642.* Geophysical activities in California. W. A. Sawdon. *Petrol. Engr*, March 1943, **14** (6), 66.—At present most of the Californian geophysical work is in and around the Sacramento Valley, where there have been gas discoveries but no oil finds of commercial importance. The reflection seismograph is the geophysical instrument most commonly used, although there are five gravity meter crews operating. Geophysical activity has gone on in the Los Angeles Basin, the Santa Maria, Ventura, and Sacramento Valleys, but the greatest amount of seismic reflection work has been carried out in the San Joaquin Valley. At first large features were sought in the San Joaquin Valley; then smaller features down to depths of 7000–8000 ft.; and later features down to 10,000–11,000 ft. Very careful interpretation is needed in order to determine small or complexly faulted structures and stratigraphic traps at these great depths. Detailed work has been concentrated in the most promising areas, such as southwest of Fresno, where the Raisin City, Helm, and Riverdale fields have been found. In these investigations the shot-lines and points are closely spaced.

This type of work is very costly, and will probably result in a higher ratio of dry holes to discoveries. G. D. H.

Drilling.

643. Chemical Influences in Drilling Mud Evaluated by Viscosity Measurements. A. W. McCray. *Petrol. Engr*, January 1943, **14** (4), 66.—The structure of clays and drilling muds is explained. In order to understand the origin of the forces acting between clay particles, it is necessary to consider the structure of the clay minerals. There are two main clay minerals, kaolinite (common clay) and montmorillonite (bentonite, widely used in rotary drilling muds). Both develop in plate-like forms, and the edges are breaks in the crystalline structure. Thus, unsatisfied atomic bonds exist at the edges of the clay crystals, and these bonds are satisfied by ions present in the water. If no salt, or acid, or base is present to supply the needed ions, then the bonds are satisfied by hydrogen ions supplied by the water itself. In the latter case the clay is known as hydrogen clay. If common salt is present in the suspension to supply sodium ions, the clay is known as sodium clay. If potassium hydroxide is present to supply potassium ions, the clay would be called potassium clay, and so on.

A balance, or equilibrium, exists between the ions associated with clay particles and the free ions in the water. There is a tendency for the ions satisfying the bonds at the edges of the clay crystals to dissociate from the clay. They leave the clay, yet linger nearby so that an overall positive–negative balance is maintained. Any of the same kind of ions existing free in solution in the water repel their kind and drive the ions back to close union with the clay. Accordingly, it can be seen that at some intermediate concentration of ions (or electrolyte) the number of dissociated ions around a clay particle will be the greatest. These ions dissociated from a clay particle have a positive charge, and they leave the clay with a net negative charge. Thus a static electrical field is built up around each clay particle, and its characteristics depend on the nature and amount of electrolyte added to suspension.

The static electrical field surrounding each clay particle is responsible for the forces of attraction and repulsion that exist between the particles. These forces were first suspected because of gelling and other static phenomena. Because of the nature of the charge distribution about the clay particles, it is possible, under certain conditions, for two particles to repel each other at certain distances of separation and attract each other at other distances of separation. Curves are presented for the energies of attraction and repulsion.

Experiments on viscosity of muds were made, and the following were the main conclusions: (1) The shape of the viscosity versus R.P.M. curve is an indication of

(*a*) whether the colloidal clay particles attract or repel each other when uniformly dispersed within the suspension, and (*b*) the strength of the attraction or repulsion forces. (2) The amount of dilution required to make the viscosity of a chemically treated clay independent of the rate of flow is a measure of the effective range of the particle charge, or the mobility of the chemical ions within the suspension. (3) The ability of a colloidal clay suspension to gel is dependent on both the amount of chemical added to the suspension and the concentration of colloid within the suspension. (4) Viscosity characteristics are not an indication of the ability of a clay suspension to form a gel, but higher viscosities may be expected in suspensions that gel because of the greater charges associated with the solid particles. A. H. N.

644.* Calculating Pump Sizes and HP. of Driver. F. B. Applegate. *Petrol. World*, January 1943, **40** (1), 44.—This forms the third and final paper on duplex power-pumps for oil-industry service, and in it formulæ derived from experimental and test data are given. Examples are worked out. Design of discharge and suction piping are discussed.

The total discharge pressure on the pump is made up of static pressure and the friction loss in the line. This total pressure is limited either by the allowable working pressure of the pipe or by the pressure in the line receiving the oil. In either case the difference between the total pressure and the static pressure will be the allowable friction loss. The discharge line must be proportioned so that this friction is not exceeded when the pump is delivering its rated capacity of oil at its maximum viscosity. When preparing the design of the discharge line, the effect of a closed or partly closed valve should be recognized and proper provision made to avoid damage to the pump or driver in case a valve is closed before the pump is shut down. A closed or partly closed valve in the discharge line will build up the pressure in any pump, but the magnitude of this pressure and its effect is not the same in all types of pumps. A centrifugal pump will build up a pressure equal to the shut-off pressure generated by its impeller, which is not sufficient to damage either the pump or the driver. A direct-acting steam pump will automatically slow down or stall, and the stalling pressure in a pump, properly proportioned, will not cause damage. A power-pump will continue to operate at speed, and will continue to build up pressure until the overload causes a motor to burn out, stalls the engine driving the pump, or damages both the pump and the driver; hence the importance of installing a suitable relief in the discharge line near the pump cylinder. A spring-loaded relief valve is cheap insurance against damage to the pump and driver, resulting from the possible closing of valves in the discharge line.

Some of the major points to observe in the design of suction piping are: (1) Locate the pump in a position that will permit using a suction line of the minimum length; (2) the diameter of the suction pipe should not be less than that of the suction opening on the pump. To keep friction losses to the minimum: (3) For long lines use pipe at least one size larger than the suction opening on the pump; (4) use the minimum number of valves and fittings; (5) use gate valves in preference to globe or angle valves—long-radius bends or long-radius ells in preference to short-radius bends, tees or standard ells. To avoid pockets or high spots in which gas or vapours will accumulate: (6) Slope the suction line up towards the pump with a uniform grade of at least 6 in. in 100 ft.; (7) when a change in pipe size is necessary, use eccentric reducers and install the reducer so that the top line of the pipe and the reducer are continuous. When long suction lines cannot be avoided, a suction air-chamber should be installed close to the suction flange of the pump cylinder. The volume of the suction air-chamber should not be less than six to eight times the displacement of the pump. The object of a suction air-chamber is to induce a uniform flow in the line by providing an elastic element to absorb inertia and cushion the effects of acceleration and deceleration.

If these points are observed and the joints on the suction side of the pump are made air-tight, few, if any, operating troubles will occur as the result of an inadequate supply of liquid to the pump. A. H. N.

645.* Rotatable Mixing Jets in Mud Tank Assure Thoroughly Mixed Chemicals. Anon. *Oil Wkly*, 15.2.43, **108** (11), 28.—A length of 3-in. pipe, laid along the full length of the tank near the one side was perforated with a series of small holes spaced at

approximately 12-in. intervals. Over each hole was welded a short nozzle of ½-in. pipe. Mounted several inches above the bottom of the tank, the pipe is held in place by several iron clamps, but the clamps are not cinched up tightly, and the pipe is free to be turned, by means of a handle located outside the tank, through an arc of about 90°. One end of this pipe enters the tank through a water-tight packing gland, and a short steel handle welded to the exposed section of the pipe permits it to be rotated. A. H. N.

646. Shell Soundproofs Test Well. L. P. Stockman. *Oil Gas J.*, 25.2.43, **41** (42), 55.—A new well is being drilled from a derrick which is sheathed. This sheathing, in addition to being practically fireproof, was deemed necessary in order to reduce drilling noise to a minimum due to the proximity of dwellings about one block away. The 132-ft. steel derrick for 1 Verne community was erected during daylight hours and in the conventional manner. Next 2 × 6-in. timbers were laid vertically 2 ft. apart from the ground to the top of the derrick on all four sides, and coarse wire mesh screen was then nailed on to these vertical timbers. Next came a series of horizontal timbers to provide anchorage for sheet transite which at present encloses every piece of equipment except the portable electrical equipment. The area between the wire screen and the transite has been filled with rock wool for a thickness of about 4 in. This insulation eliminates practically all the noise incident to drilling. In order to provide ventilation and at the same time keep the derrick free of gas, a series of enclosed fans and air vents has been provided. When this test got under way it was decided to permit the pumps and shakers to remain in the open, but it was soon found that a slight humming noise was audible some distance from the well, and accordingly the pumps and shakers were completely insulated by erection of a soundproof shed. Los Angeles city ordinances prevented the company from enclosing the principal electrical equipment, but with this exception everything on the property is enclosed and soundproof. A high board fence has been erected around the rig, and admittance is by a special pass only.

Drill-pipe is pulled off the rack in the conventional manner, except that in Shell's Verne community well a door for the A-frame opening has been provided that slides vertically along a track that keeps the door from swaying. The door which extends down to the base of the derrick is operated from the cathead by a line running from the top of the door to a pulley just below the run-around, and thence to the derrick floor. After drill-pipe has been placed on the derrick floor or laid down on the rack, the door, which is also insulated in the same manner as the entire derrick, is again dropped, being kept in place by the runners or tracks along which it moves. Electrical equipment was decided upon for convenience, and because it dispensed with steam and was more suitable for noiseless drilling and at the same time provided positive direct control. Large pumps are being used, and the shakers and mud-tanks are enclosed in a compact unit. Two 2500-brl. tanks have been erected and lead lines have been laid from the well to the tanks. In order to keep the well under control at all times, the company is using three blowout preventers. Extraordinary safety measures have also been taken to permit the derrick man to get out of the enclosed derrick in case of emergency. Shell spent approximately $9000 rigging up this well before it was spudded. The precaution taken in the drilling of this miocene test is cheap protection against what might prove a costly undertaking if the well should get away, not to mention the possible effect of such a condition on future drilling within the corporate limits of the city of Los Angeles. A. H. N.

647. Mud Conditioning in Embar Field. H. F. Simons. *Oil Gas J.*, 4.3.43, **41** (43), 39.—Mud-conditioning is one of the principal factors in the drilling to the deep Ellenburger pay (approximately 7900 ft.) in the new Embar pool of Andrews County, Texas. One company has developed a tank which is included in the mud system and which performs a number of tasks. The tank permits the ready addition of chemicals to the mud and can be used for batch mixing if necessary. However, its main purpose is to separate the shale and cuttings from the drilling mud before the mud enters the regular circulating pits. It is also used as a temporary storage while getting and cleaning out pits. The rig with which the tank is used is the regular two-motor compound type with the pump located back of the prime movers. The pits used customarily with such rigs are L-shaped, the flow-line from the well entering

the pit which is parallel to the drilling equipment. The mud then flows the length of this pit and makes a turn (generally through a boarded ditch) into the second pit, and thence to the pump suction. This is the pit system used at Embar. The mud system is described in detail.

The outlet from the tank is through a funnel located in the centre. This funnel is about 18 in. in diameter to the top and reduces down to 7 in. The top of the funnel is approximately 3 in. below the bottom of the flow-line entering the tank. The mud coming into the tank sets up a slow circular motion, with the quietest portion being that towards the centre and, consequently, most of the cuttings settle out, and virtually clean mud passes out through the funnel. The tank is also equipped with two fluid-operated jets located on opposite sides from each other. These jets are connected to lines leading to the reserve pit into which the shale is ejected. A platform on the derrick side of the tank is equipped with a mud-gun, the necessary connections and valves for operating the jets and the gun, a fresh-water line, and a barrel for mixing chemicals. This barrel lies on its side, with a portion of the uppermost side removed. A valve at the lower end allows regulation of chemical flow into the mud.

Mixing and jetting of the muds and details of its properties are given. A. H. N.

648. Simple Maintenance of Electrical Equipment may Prevent Costly Shutdowns. E. H. Lamberger. *Oil Gas J.*, 4.3.43, **41** (43), 46–48.—Concise directions are given on the proper maintenance practices are precautions to be taken in working with motors and generators and their parts, such as current collectors and commutators and bearings, with control equipment and transformers. A. H. N.

649. Steam Consumption of Reciprocal Pumps. W. L. Nelson. *Oil Gas J.*, 11.3.43, **41** (44), 46.—The steam required to pump 100 g.p.m. of liquid at a pressure of 100 lb./sq. in. gauge pressure using 125-lb. (gauge) steam is approximately 1000 lb./hr. This constant is based on the fact that the volume displaced from the liquid cylinder of a pump is the same as the volume of steam required to fill the steam cylinder if the steam pressure is the same as the liquid discharge pressure—and corrected, of course, for the inefficiency of the pump. The steam quantity can be easily converted to pounds by means of its density or specific volume. A. H. N.

650. Troubles from Salt Sections, Hard Formations, Impede Embar Drilling. H. F. Simons. *Oil Gas J.*, 11.3.43, **41** (44), 57–59.—Mud treatment required by a salt section in the Permian formations, tool-joint failures, and cherty formations just above the Ellenburger pay horizon are the principal difficulties encountered in drilling wells in the Embar pool of southern Andrews County, Texas. This field is one of the major West Texas discoveries of the last year, has two good producing horizons and one not so good, in addition to the usual gas-bearing formation in the Yates. The geology of the field is discussed. Drilling practices are then reviewed.

If all the salt section is not cased off, the salt-water mud used consists mainly of native clay and material which will increase the viscosity slightly. Such a fluid will show a high water loss (50–80 c.c. in 30 minutes) and a correspondingly thick filter cake. This mud allows the salt to go into solution, which forms cavities in the upper part of the hole, and permits the shales to be continuously wetted with consequent sloughing. Another difficulty which arises from the formation contents going into solution with the water in the mud is the failure of the drill-pipe. There are a number of sulphurous compounds involved, and undoubtedly some hydrogen sulphide. The drill-pipe failures exhibit many of the characteristics of hydrogen sulphide embrittlement. Mud problems are further discussed.

The field is being drilled with 3½-in. drill-pipe with no troubles attributable to it. Rotating speeds are low, from 90 to 150 r.p.m., with some drillers using only 70 r.p.m. for drilling the anhydrite. Practice is to core and drill completely through the pay and then run the 5½-in. pipe to bottom. The float and cement are then drilled out of the pipe, but the guide or float shoe is left intact. The drilling of the cement is done with 3-in. flush drill-pipe. The casing is then gun-perforated. Rigs used in the field are mostly late-model power rigs using either two gas or diesel engines. One rig has a three-engine hookup. Total horse-power of engines on rigs at Embar

runs from 370–600 h.p. The 126-ft. derricks are set on substructures. As it takes from 70–90 days to drill the deeper Ellenburger wells and 45–50 days to drill the Tubb wells, the rigs are well assembled. A. H. N.

651. Slim-Hole Drilling in Barnhart Field in West Texas. H. F. Simons. *Oil Gas J.*, 18.3.43, **41** (45), 48.—The slim-hole programme followed generally in the field was inaugurated in the first well, which set 627 ft. of 10¾-in. casing, 2225 ft. of 7⅝-in. casing, and 9017 ft. of 5½-in. pipe. The discovery well had over 7000 ft. of open 6¾-in. hole before the oil string of casing was run in it. The string of pipe run to 2225–2250 ft. shuts off the salt section between 1080 and 2180 ft., the gas sand found at 2200 ft., and eliminated considerable mud trouble. While drilling the hole for the intermediate string, loss of circulation is not uncommon. The drilling of a well to below 9100 ft., with 7000 ft. of open hole is something of an accomplishment, and when the hole drilled is only 6¾-in. in diameter, a great amount of care must be taken to prevent troubles. The drill-pipe used is 3½ in. in diameter, and a stuck string of pipe is really difficult to free. It would be practically impossible with present mud technique to drill the well without casing off the salt, anhydrite, and gas-bearing zone already mentioned by running the intermediate string.

With the upper zones, which might complicate the mud problem, cased off, there is still not complete freedom from mud troubles. Generally the hole stands up quite well, with the exception of the interval from 3800–4700 ft., which is shale, and sandy and limy shale. There are some sands in this interval which flow salt or sulphur water and which cause the mud to have a high viscosity and water loss if not controlled. A mud weighing 9·6 lb./gal. will hold the water in the formation, and a further seal is obtained by using 20–25 sacks of "Impermex" plus quebracho and caustic soda while drilling this section. This gives a low-water-loss mud which plugs off the formation. Mud is maintained at 9·6–9·8 and at a viscosity of 33 or 34 seconds A.P.I. until 8800 ft. is reached. If the mud is not properly maintained, and if the pits are not kept clean and free from shale and cuttings, trouble with sticking pipe may be encountered. Keeping the water loss as low as possible helps, and prevents the greenish-grey shale around 4700 ft. from caving due to being wetted.

At 8800 ft. the mud is prepared for drilling the pay section by removing as much of the solid materials as possible, and then adding 3000 lb. of "Impermex," 1200 lb. of caustic soda, and 500 lb. of quebracho. This brings the water loss down to 2–4 c.c. in 30 min. at 100 lb. pressure, which prevents infiltration of water into the formation. The pay is then drilled and an electric log run to bottom, after which the casing is run. The pay is quite soft, and a substantial increase in the drilling rate is noted when it is encountered.

Casing programme and other details are given. It takes from 70 to 80 days to drill a well. A. H. N.

652. Patents on Drilling. C. D. Cantrell. U.S.P. 2,309,625, 2.2.43. Appl. 3.10.40. Sampling apparatus for obtaining representative samples of fluid flowing through a conduit.

C. S. Sanders. U.S.P. 2,309,791, 2.2.43. Appl. 13.9.40. Method and apparatus for cementing wells, using rotation and wobbling of casing.

R. E. Fearon. U.S.P. 2,309,835, 2.2.43. Appl. 14.2.41. Well-logging apparatus and method for detecting structural characteristics.

J. R. Gardner. U.S.P. 2,309,839, 2.2.43. Appl. 31.8.40. Float collar for well-pipes.

J. E. Reed. U.S.P. 2,309,866, 2.2.43. Appl. 5.8.41. Safety-joint bumper sub.

D. N. Shaffer and E. C. Hamm. U.S.P. 2,309,872, 2.2.43. Appl. 20.11.40. Hydraulic trip tool-jar for jarring well-tools.

D. H. Weinstein and L. H. Metzner. U.S.P. 2,309,877, 2.2.43. Appl. 8.1.38. Device for determining inclination of well-bores.

E. M. Irwin, B. H. Rule and G. E. Lewis. U.S.P. 2,309,905, 2.2.43. Appl. 27.1.39. Device for surveying well-bores with means to transmit signals to the surface.

H. H. Vanderzee. U.S.P. 2,309,999, 2.2.43. Appl. 23.5.39. Rotary drilling apparatus with hydraulic drill-rod feeding means.

J. W. Haddock. U.S.P. 2,300,001, 2.2.43. Appl. 27.3.40. Apparatus for cleaning holes by high gas-pressures.

D. B. Grable. U.S.P. 2,311,225, 16.2.43. Appl. 8.1.40. Pipe rotating apparatus, in the form of pipe-tongs with special gripping arrangements.

H. N. Marsh. U.S.P. 2,311,312, 16.2.43. Appl. 17.2.42. Continuous mud-weight indicator.

J. J. Jackosky. U.S.P. 2,311,757, 23.2.43. Appl. 25.2.38. Thermometric method and apparatus for exploration of boreholes.

G. McCray. U.S.P. 2,311,768, 23.2.43. Appl. 12.11.40. Casing centering apparatus for use in boreholes.

C. L. Deckard. U.S.P. 2,311,932, 23.2.43. Appl. 2.3.42. Hinged-finger adjustable pipe-rack.

C. L. Deckard. U.S.P. 2,311,933, 23.2.43. Appl. 2.3.42. Safety pipe-rack for use in derricks.

A Shacklette. U.S.P. 2,312,126, 23.2.43. Appl. 14.9.42. Shock absorber for use on walking beams of drill-rigs.

J. R. Yancey. U.S.P. 2,312,205, 23.2.43. Appl. 9.8.41. Oil-well equipment, including a casing-head and oil-well foundation equipment.

M. Lintz. U.S.P. 2,312,343, 2.3.43. Appl. 1.2.41. Vibrating screen.

H. C. Pollitz. U.S.P. 2,312,477, 2.3.43. Appl. 3.8.40. Vibrating screen.

R. A. Steps. U.S.P. 2,312,600, 2.3.43. Appl. 2.1.41. Well mechanism for cementing pipe in a well.

F. L. le Bus. U.S.P. 2,312,656, 2.3.43. Appl. 28.6.41. Whipstock deflecting tool for oil-wells.

P. W. Appleby. U.S.P. 2,312,789, 2.3.43. Appl. 1.2.39. Well-tool for cleaning the walls of a well by means of fluids under pressure.

O. L. Derrick. U.S.P. 2,312,804, 2.3.43. Appl. 13.2.40. Guide for kelly-bars and drill-stems.

L. A. Douglas. U.S.P. 2,312,805, 2.3.43. Appl. 19.6.41. Means for laterally entering subterranean strata and withdrawing the pore content thereof.

J. A. Bermingham. U.S.P. 2,312,862, 2.3.43. Appl. 26.1.40. Method and apparatus for completing wells by underreaming and using a liner screen.

W. J. Opocensky. U.S.P. 2,313,168, 9.3.43. Appl. 25.4.40. Inclination and directional device for boreholes.

R. B. Sprague. U.S.P. 2,313,177, 9.3.43. Appl. 3.12.40. Blowout preventer and valve.

G. D. Johnson. U.S.P. 2,313,243, 9.3.43. Appl. 9.10.40. Elevator link for handling pipe or casing.

P. M. Rea. U.S.P. 2,313,263, 9.3.43. Appl. 24.5.41. Overshot fishing-tool.

H. Allen. U.S.P. 2,313,308, 9.3.43. Appl. 6.1.41. Casing-head.

J. C. Arnold. U.S.P. 2,313,310, 9.3.43. Appl. 4.8.40. Well-bore radiation logging apparatus.

R. E. Lea. U.S.P. 2,313,384, 9.3.43. Appl. 28.4.39. Means for determining the tectonics and nature of subsurface geology by means of using the drill-stem as an electrical logging apparatus.

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Production.

653. Secondary Recovery May Have Vital Rôle in the War Effort. P. D. Torrey. *Petrol. Engr*, January 1943, **14** (4), 1160.—The author is the chairman of the Standing Sub-committee on Secondary Recovery Methods, American Petroleum Institute, and in this paper he details some of the committee's findings. The general programme of the Standing Sub-committee on Secondary Recovery Methods at the time of its organization was: (1) To demonstrate that the petroleum industry has not been unmindful of its obligations to conserve the available oil resources of the nation. (2) To assemble information and compile data on many existing secondary recovery operations in the United States. (3) To provide theoretical and practical information to serve as a guide for the efficient recovery of oil. (4) To develop interest in the preservation of marginal properties and fields, which otherwise might be abandoned unless some method for the stimulation of production were applied.

The importance of secondary recovery operations in the production of oil is more apparent in certain of the eastern States than elsewhere. This may be demonstrated most impressively by citing an increase in production in New York of 600% since 1912 and an increase in production from the Pennsylvania part of the Bradford field of 800% since 1912. These substantial gains may be attributed directly to the application of secondary recovery methods. A summary of some statistics relating to the magnitude of secondary recovery operations in the United States, as compiled by the A.P.I.'s Standing Sub-committee on Secondary Recovery Methods, reveals that a minimum of 306,282 acres of oil-productive territory was affected, on which there are some 50,636 producing wells and 34,956 injection wells. These comprise some 1236

different projects in 254 separate fields, with an estimated plant investment of $281,496,000. The value of secondary recovery oil produced in the United States during 1942 is estimated to be $84,000,000.

The influence of secondary recovery operations on total production in Kansas and Oklahoma is becoming of greater prominence, as both water-flooding and systematic gas repressuring projects, initiated several years ago, are beginning to reach the peak stages of production. The successful results obtained in many of these projects cannot fail to encourage further expansion of secondary development. There can be little doubt that the production from secondary recovery operations in these States will have a stabilizing effect and will serve to reduce the rate of decline that can be expected from the primary production. Secondary recovery operations in the great productive areas of the South-western States are not nearly so important in relation to total oil production as in the Eastern and Mid-continent areas, although there are more gas repressuring projects in Texas than in any other State. In both Texas and Louisiana moderate secondary recovery programmes are serving to maintain many oil-fields in profitable operation, and thereby are preserving important reserves of oil that might otherwise be lost if the fields were abandoned.

The adaptability of fields to secondary recovery is briefly discussed. A short forecast on the future of secondary recovery ends the paper. A. H. N.

654. Applying Engineering Methods to Pumping Wells. A. S. Ross. *Petrol. Engr*, January 1943, **14** (4), 124.—One of the most basic and important features of a pumping well is its speed of operation. This factor affects the peak load and the distribution of power throughout the stroke cycle. For example, on one well pumping with a standard rig at Smackover, Arkansas, dynamometer tests showed that by increasing the speed from 29 to 32 s.p.m. the peak load was decreased 1250 lb., with a small increase in polished rod h.p. and a corresponding increase in production. The problem is one of determining the speed that produces the best harmonic motion in the rod-string. This may be done very simply by use of Slonneger's formula—frequency $= \frac{237{,}000}{\text{depth, ft.}}$. Thus, for a 6,000-ft. well, frequency $= \frac{237{,}000}{6000} = 39{\cdot}5$. From this frequency of 39·5 it may be shown that pumping speeds of an uneven or half order, such as $\frac{39{\cdot}5}{3{\cdot}5} = 11{\cdot}3$ s.p.m., $\frac{39{\cdot}5}{2{\cdot}5} = 15{\cdot}8$ s.p.m., and $\frac{39{\cdot}5}{1{\cdot}5} = 26$ s.p.m., produce the most harmonious or efficient motion in the rod-string. As the 3·5 order speed is too slow and the 1·5 order speed too fast, pumping speeds of 15–16 s.p.m. would produce the most desirable results. Following up this line of reasoning, a group of wells pumping from 6000 ft., which had given considerable trouble due to tubing breaks, was studied to determine the source of the failures. It was found that all breaks had occurred on wells pumping at 18, 19, or 20 s.p.m. When these wells were slowed to 16 s.p.m. the trouble was eliminated and no further breaks have occurred. Production was maintained by lengthening the stroke or enlarging the pump diameter, when necessary.

Having established the proper pumping speed, the length of the stroke and pump diameter should be chosen to obtain the desired production. The above formula and method have been found to give good results in wells below 3000 ft., but they should be checked with a dynamometer when possible, especially on shallower wells. Field studies have shown that dynamometer tests are of actual value, mainly as a basis of comparison between the conditions in a well before and after a change in operation is made. Certain characteristics can, however, be detected from the shape or general appearance of the card.

Another factor in the study of the pump action is the actual pump stroke obtained at the bottom of the well. This factor may be calculated with reasonable accuracy by Rieniet's formula or by the newer formula proposed by Dralle and Lamberger. Rieniet's formula :—

$$S_p = \frac{Q_s}{K} + S_s(\cos 0) - 2\frac{W_t}{K}$$

Dralle and Lamberger formula :—

$$EPS = \frac{S}{\cos(0{\cdot}0004LN)^\circ} - \frac{W_{OD}L}{2(10)^6}\left(\frac{1}{A_s} + \frac{1}{A_r}\right)$$

Where—EPS = effective plunger stroke; in., S = polished rod stroke, in.; $\cos(0{\cdot}0004LN)^\circ = 1 - \frac{X^2}{2} + \frac{X^4}{24}$ and $X = \frac{0{\cdot}0004LN}{57{\cdot}3}$; L = length rods, ft.; N = strokes/minute; A_R and A_T = cross-sectional area of rods and tubing, sq. in.; and W_{OD} = differential fluid load, (wt. of net fluid head on the full area of plunger), lb.

A simple empirical formula that may be used as a rule of thumb has been derived by Slonneger as follows:—

$$\text{Stretch in in.,} = \frac{\textit{Depth (ft.)} \times \textit{stroke, in.} \times \textit{s.p.m.}}{303{,}000}$$

This formula, although not always applicable, may be used for medium depth wells when a normal pump and rod-size are used and at pumping speeds of 20 s.p.m. or higher.

Torque and horse-power calculations are also included. In conclusion, the main factors to consider in an engineering study of a pumping well are: (1) The speed of operation, which should be chosen to give the best harmonic motion in the rod-strings; (2) the selection of the correct size pump for the fluid to be handled and the proper type pump for the well conditions; (3) the valve action and service in the pump; (4) the service given by the rods and tubing; (5) correct counter-balancing of the pumping unit; (6) the selection and operation of the prime mover; (7) the spacing of the subsurface equipment. A. H. N.

655.* An Estimate of California Gas Reserves. Anon. *Petrol. World*, January 1943, **40** (1), 28–33.—Natural gas occurs in California and elsewhere as well, in two ways or modes, first as a separate and distinct product unassociated with deposits of liquid hydrocarbons or petroleum, in which case it is called "dry gas," and secondly, associated with liquid hydrocarbons in the underground reservoir, being produced concurrently with the liquid phase material and separated at the surface or casing-head of the well from the liquid oil, from whence comes its name, "casing-head gas." Since the gaseous and liquid hydrocarbons exist coextensively in the reservoir, and since there is no clear line of demarcation between gas and liquid material, the composition of each phase depending on the temperature and pressure existing at the time of separation, the casing-head gas as customarily produced contains border-line material consisting of readily liquefiable hydrocarbons which can be removed by compression and absorption in a casing-head gasoline plant, leaving a "dry" casing-head gas in distinction from the "wet" gas which was produced and separated from the oil at the casing-head.

The total future production of gas from both dry gas and oil- and gas-fields has been estimated by methods appropriate to the type of occurrence involved, and the reserve figures shown are the summation of those estimated total future productions, and are not to be understood as amounts of gas available to utilities or other consumers, since no deductions have been made for field use or shrinkage occurring when casing-head gasoline is extracted from the wet casing-head gas.

Dry gas was estimated by the saturation method and by the pressure-drop volume method. Considering the State as a whole, the 1941 production was about one-thirtieth of the total reserve. However, this should not be interpreted as meaning that the reserves will provide for the State's needs for a corresponding period. Unless important new reserves are discovered or major changes made in modes of utilization and distribution, serious shortages may result in some areas long before the period indicated by the above ratio, because of the increasing rates of withdrawal for general service and war production purposes. A study has been made of the approximate purposes of the gas reserves which may be available for general public uses after the necessary use of gas in the fields by the producing companies. For this purpose the dry gas-fields have been considered as wholly available for public uses. In respect to the casing-head gas reserves, the ratios existing between the present rate of gas available to utilities and the present rate of production from the individual fields have been used. It should be pointed out, however, that these ratios may not obtain for the future. Based upon such ratios, however, approximately 70% of the casing-head gas reserves may be considered available for general public purposes. By combining dry gas reserves with approximately 70% of the casing-head gas reserves it will be

found that slightly over 10 billion m.c.f. of gas reserves exist in the State which at this time appear to be ultimately available for public usage. A. H. N.

656.* Consideration of Well Characteristics in Design of Intermitter Installations. F. Briggs. *Oil Wkly*, 15.2.43, **108** (11), 14–16.—General principles of intermitter design are explained. Of prime consideration in the design of a setting for an intermitter is the determination of the static fluid level or the bottom-hole pressure from which the fluid level may be calculated. This well characteristic is necessary for selecting the position of the intermitter valve, the accumulation chamber design, and the method and means for unloading the fluid from the casing preparatory to beginning the intermitting cycle. The next factor considered is the amount and pressure of the gas available. This gas, except in rare cases, is introduced into the producing well from an outside source, and must be sufficient in quantity for continual operation, of great enough pressure to lift the length of fluid column produced during a cycle. Depending on the amount of fluid, the average operating pressure in most intermitter wells ranges from 200 to 350 p.s.i.

Another valuable determination is that of the well's productivity index. This term represents the relationship between producing subsurface pressures and production rates. It is defined as the "brl./day of gross liquid produced/lb./sq. in. of pressure" from a specified depth in the well. This productivity index indicates where the working fluid level of the well will remain at the desired production is obtained. Correlating this information with the bottom-hole pressure figures, the chamber, valve setting, and packer position may be determined. These three factors are discussed in some detail. Certain unusual types of installations are also discussed.

Among the troubles of intermitters are paraffin and corrosion. The use of gas in lifting fluid often accelerates the accumulation of paraffin on the tubing walls at certain depths in the well, due to the cooling effect of the expanding gas approaching the surface. In all cases this condition can be remedied by regular scraping or washing with a solvent. Corrosion and hydrogen sulphide often detrimentally affect intermitters, especially those requiring the use of wire lines. In the past this was solved by using model lines, or wires of similar resisting properties. As most valves are constructed of high-alloy steels, the main problem has been in the protection of the connecting link between surface control and intermitter valve. Those operating by pressure control have been least affected by corrosive action. The unloading system of certain intermitters is not designed for operation in wells with high fluid levels. Where various manufacturer's equipment is used in conjunction in the process of unloading the well, satisfactory results are not always obtained. Such equipment will operate perfectly under fluid conditions for which it was designed. There are intermitters with proper valves for the unloading procedure. A. H. N.

657.* Calculation of Actual and Effective Counterbalance. Part 2. E. N. Kemler. *Oil Wkly*, 15.2.43, **108** (11), 19.—In this part of the paper Professor Kemler discusses in greater detail the problem of counterbalancing wells than he used in Part 1. Methods of determining velocities graphically are outlined. Torque and horse-power calculations using velocities are then given. An example is worked out in full to illustrate the method. A. H. N.

658.* Driving Unit Shift Avoids Belt Replacement. Anon. *Oil Wkly*, 15.2.43, **108** (11), 37.—In California, where purchased power is used, advantage is taken of the decline in production rate in many fields by the installation of a 3- to 5½-horse-power electric motor at the bandwheel, instead of at the far end of the belt-house. By using the compact type of motor and gear unit combined, and by setting the driving unit base directly on one beam of the bandwheel support, it is possible to supplant the wide belt with a comparatively short roller-chain drive. If the large sprocket on the bandwheel shaft be made in two parts, and split to clamp around the shaft, no dismantling is necessary in making the shift to the new drive.

When installing the gear-and-motor combination, one California company cuts the number of pumping strokes from 18 to 6/minute, reducing wear-and-tear on the lifting equipment, and thus extending its service lift over a period during which replacements would be difficult if not impossible to secure. Through the installation of thermo-

static protective devices on the motor, provision is made against damage through overload or running away of the unit in case of a rod break. Provision of push-button control enables the unit to be operated from a central station when desired, with pumping sequence arranged to give uniform current draft over the entire lease or company holdings. A. H. N.

659. Combat Corrosion in West Texas. H. F. Simons. *Oil Gas J.*, 25.2.43, **41** (42), 61.—The paper deals with corrosion problems in the production department of a field claimed to be the worst in Texas, if not in the world, for corrosion. Many attempts have been made to solve this problem. The latest has been the installation of cement-asbestos fibre-pipe in the flow-lines for the purpose of reducing or eliminating corrosion there, and stray electric currents which may affect the tubing. So far it seems to be producing results, although sufficient time has not elapsed to credit the step with any outstanding success.

The cement-asbestos pipe was put into use after tests for stray currents were made in the field. So many electrical currents were found that the situation was more confused than clarified. Also, the results of surveys did not correspond with those usually found, and it was almost impossible to reach any conclusion from them. Insulating flanges had been installed in the field, and they are still in place, but it was hoped that the use of a non-conductor pipe might eliminate some of the currents and some of the corrosion. At the worst, no harm could result from such a step, and at least the corrosion in the lead lines would be stopped. Many of the operators in the field do not agree with the stray electric-current theory, but believe that corrosion is due to direct chemical attack by the water produced with the oil. This water not only contains the usual salts, but also has a high hydrogen sulphide content. To add a little substance to the contention of this group, the corrosion is mainly on the inside of the flow-lines and tubing, although there is some outside corrosion.

In some cases wells must be pulled as often as once a week to search for leaks in the tubing. When the leaks are large they are easily found, but when small a pressure test must be used. Operators in the field are equipped with modern pulling units and have special equipment for testing the tubing while standing in the derrick. On one well, two pulling jobs were recently necessary in one week. The first time a leak was found at about 1800 ft., and the second time a split was found at about 2800 ft. 200 ft. off bottom. Outside the tubing there was little corrosion in the hole and about the normal corrosion near bottom. The tubing used is H-40, 2½-in. external upset, and is a little over a year old.

Various remedies are briefly discussed. A. H. N.

660. Air-Drive Experiments on Long Horizontal Consolidated Cores. H. Krutter and R. J. Day. *Oil Gas J.*, 25.2.43, **41** (42), 64.—Results of experiments on relatively long cores show that (1) relative permeability to air as a function of per cent oil saturation for a given core is independent of pressure gradient in the saturation range up to 85%. (2) Air–oil ratio expressed in volume of oil for a given core is independent of pressure gradients within the saturation range of 55–85%. (3) The ultimate recovery obtained using air drive on an originally 100% saturated core depends on the pressure gradients used. The higher the pressure the greater the recovery until an optimum pressure is reached, after which no appreciable gain in recovery is obtained with further increase in pressure. (4) Approximately 50% recovery may be expected from a core initially 100% saturated with oil. There is a small variation in this amount, depending on the characteristics of the sand. (5) Constant high-pressure maintenance is shown to lead to a greater recovery than is obtained by a gradual stepwise increase in pressure. However, the relative difference is not so marked as in experiments using radial cores. (6) Gas drive, although more advantageous from the viewpoint of cost, did not result in any increased ultimate recovery when compared with air drive at the same pressure. (7) Relative permeability to methane as function of per cent oil saturation is the same as the relative permeability to air as a function of oil saturation. (8) Water drive following air drive showed a remarkable increase in recovery. The possibilities of the use of water drive following air drive deserves further laboratory study as well as field experimentation. (9) One experiment though insufficient indicates that air drive followed by water drive may be more efficient in ultimate recovery than an original water drive. (10) The presence of

connate water in the sand may quantitatively affect the results of 8 and 9, and therefore these experiments should be repeated to determine what effect connate water has on the results. A. H. N.

661. Determining Capacity of Reciprocating Steam Pumps. W. L. Nelson. *Oil Gas J.*, 25.2.43, **41** (42), 83.—The capacity of a regular duplex double-acting reciprocating steam pump is equal to about half the product of the stroke (inches) and the square of the diameter (inches) of the liquid cylinder. For simplex pumps the capacity is about half as much as the above—or is equal to about one-fourth the product of the stroke and the square of the cylinder diameter. Finally, belt or gear-reduction-driven pumps of either the duplex or triplex types have a capacity about 1½ times greater (factor is 0·75) than that of the regular duplex. These rules are approximately only and have no theoretical background. They are based on observation only of actual capacities. A. H. N.

662.* Counterbalancing of Central Powers. E. Kemler. *Oil Wkly*, 1.3.43, **108** (13), 31.—The peak load or torque which can be imposed upon a central power can be several times the average load or the load necessary when the power is properly counterbalanced. The problem of determining the location and size of the counterbalance is a complicated procedure. Several methods are available, and each does the job in the same general manner. Most of those in use employ graphical methods and require that force diagrams be made. The disadvantage of these methods is that changes in the diagrams are necessary when wells are unhooked or hooked on. The method described uses the same data as the graphical method, but reduces everything to a tabulation basis, so that the data can be used for any well combination and the adding or taking off of a well only requires re-adding the data. When a power has a complicated pumping schedule, this method will save much time.

The torque on the power caused by any one well at any point will be the component of the rod-line pull at right angles to the crank times the crank arm. Since the ratio of crank radius to Pitman length is large, the well load can be considered as acting parallel to the zero position, where the crank is in line with the rod line. The torque is then equal to the well load times the sine of the angle between the crank and zero position multiplied by the crank radius. The method is illustrated by an example which is worked out in detail. A. H. N.

663. Calibration of Horizontal Cylindrical Tanks. H. David. *Oil Gas J.*, 4.3.43, **41** (43), 49–50.—A method for calibrating horizontal cylindrical tanks by means of depth and diameter measurements and using a chart is given. Flat ends are assumed. A. H. N.

664.* Special Plant Treats Heavy Crude Emulsions Efficiently. G. M. Wilson. *Oil Wkly*, 15.3.43, **109** (2), 14.—A centralized crude-oil-treating plant of special design, employing direct-fired heaters, the first of its type to be used for this purpose on the Pacific Coast, has been giving exceptionally successful service since its installation by a large producing company to treat the extraordinarily difficult emulsion problem in the heavy oil produced in one of the coastal fields. The plant wet-oil flow system is unusually flexible in moving the difficultly handled heavy crude.

Entirely automatic in operation, the plant treats oil which averages 14 gravity and the cut of which averages up to 20%. The oil itself is extremely viscous, more so that the average of crudes of like gravity in other fields, and emulsions are very difficult to break out. The plant originally consisted of 4 direct-fired heaters and a battery of 8 electric dehydrator units, but plant capacity has recently been increased from its original of around 12,000 brl./day to approximately 18,000 brl. daily by the addition of 2 heaters and 4 dehydrator units. Pumping equipment of the plant was also increased proportionately. A skimming pond of novel design plays an important part in holding treating costs and waste down to an absolute minimum with no impairment of plant dehydration efficiency. The pumping units are described.

The electric dehydrators are 28,000 volt, double-transformer units, each using two sets of concentric ring electrodes. As the water is separated out and falls to the bottom of the dehydrator units, it is automatically drained off at intervals through the operation of electrically controlled valves. Each unit has one of these automatic bleeders

mounted on the outside of the shell. Cleaned oil is removed from the top of each unit and is withdrawn through an overhead 10-inch collecting line, which runs the full length of the battery of dehydrators. Dry oil averages less than 2% cut, and after leaving the dehydrators goes over to the dry-oil receiving tank, where it joins the dry oil coming into storage directly from the field.

Pressure in the dehydrators is maintained at 35 lb./sq. in. Because of the slight differential between the gravity of this oil and that of water, it is necessary that temperature and pressure conditions be maintained as nearly constant as possible. The all-automatic features which control these conditions have been largely responsible for the high degree of efficiency and smooth operation of the plant. In addition to these automatic controls, a manual control for each individual unit is located in the control-room at one end of the bank of dehydrators. This room has two banks of control panels, one on either side of the room, with each of the panels corresponding in position to one of the units. Wiring is so arranged that any single unit or bank of units may be cut out of the system at any time. Likewise, either electrode of any one unit may be cut out, if desired, without affecting the operation of the remaining units.

Other parts of the plant, which has been working since January 1942, are described. A. H. N.

665. Water Production Creates Corrosion Problems in Western Kansas. N. Williams. *Oil Gas J.*, 18.3.43, **43** (45), 41–43.—Increasing water production in Western Kansas fields is presenting additional difficulties for operators in combating corrosion. Special practices are being adopted for controlling the water and protecting equipment. In this article some of the conditions as they pertain to these practices are discussed. Constant pumping rather than intermittent pumping at higher rates has been found to reduce corrosion in the annulus. The reasons are explained. Sealing the annulus by packers has also been tried with qualified success.

The combating of corrosion inside the tubing has involved numerous complications, and no solution to the problem has yet been found. A number of operators have recently been experimenting with cement-lined tubing. In this, although the tubing is protected, wear on rods is great and more frequent breaks result. Rods can be worn completely in a surprisingly short time by the cement. Rod-guides of various materials and types have been installed on rod-strings to protect the rods, but these can be little larger in diameter than the rod couplings, and also soon wear too small to do any good. Also, some types jam up in the hole and cause trouble in pulling rods. Major benefits have been derived in the past by use of rods and couplings of high nickel content and having other corrosion-resistant alloys and qualities, but such rods are now almost unobtainable. As operators resort to rods made of less adaptable materials, corrosion becomes a more serious matter.

Some good is resulting from use of tapered rod-strings. The combinations usually run consist either of ⅞-inch and ¾-inch, or 1-inch and ⅞-inch strings. The larger size in each case is run on the bottom, where exposure to water is greater. It stands more corrosion or wear before breaking and requiring replacement. On the surface, operators are going almost 100% to asbestos-cement pipe for lead lines and all other lines in which water is handled. In the former use of steel pipe leaks became frequent, and most lines had to be completely replaced in from 1 to 2 years. No high pressures are involved, so the asbestos-cement type of pipe is strong enough. In some cases operators have devised couplings, bends, "T"s, and other fittings made of concrete, using about 50% cement and 50% fine sand.

Chemical treatment of the water in the wells as it is produced to neutralize the corrosive action has proved effective in many instances. The chemical mixture and method of treatment in these cases were developed by Cities Service Oil Co. which is not only treating a number of its own wells, but also some of other companies. The chemical mixture contains a concentrated caustic soda with colloidal material (tannic acid). Caustic soda is the neutralizing agent, but if injected without the colloidal agent to retain the water solids in suspension, it might cause the solids to precipitate and accumulate around the pump intake and clog the well. A. H. N.

666. Factors Affecting Expansion of Kansas Water-Flooding. P. Reed. *Oil Gas J.*, 18.3.43, **41** (45), 62.—The present trend in South-eastern Kansas is for water-flooding

to supplant gas injection because of its greater effectiveness. In explaining the relatively low efficiency of gas injection, Muskat observes that laboratory evidence leads to the conclusion that the total increased depletion of oil as a result of gas injection is at best only slightly greater than that which results from the natural primary recovery operations if the latter were continued to the physical limits of pressure depletion. Hence the major economic contribution of the gas injection operation is derived from the fact that it makes available at commercially profitable rates of production that oil which cannot be obtained during the primary recovery stage at sufficiently high rates to warrant continued operation. Even though other phenomena in the field may make it possible to obtain total ultimate recoveries exceeding those corresponding to the recovery curve, there seems little evidence that the gas-injection process in depleted formations can approach the efficiency of the water-flooding process.

Given the essential conditions for profitable flooding, such as a sufficient amount of residual oil in a sand, with desirable characteristics of uniformity and permeability, located where ample supplies of water are available, the operator must reach decisions regarding policies to be followed. More rapid recovery calls for higher development costs entailed in closer spacing of wells and heavier shooting. With this programme may go higher water-injection pressures and the practice of pumping rather than flowing producing wells. However, the comparative advantages of pumping and flowing continue to be debated. With a shorter period before the peak is reached, the larger oil production yields an income which returns the cost of investment more rapidly; consequently interest charges are reduced. Such advantages must be weighed against the desirable economies achieved by a slower policy.

In making an effort to see as far ahead as 10–15 years, it appears highly probable that the spreading of water-flood operations will sustain the present rate of production for over such a period. In this article conclusions of students of the technique have been cited to indicate the close relationship of price of crude oil to other factors involved in profitable water flooding. A substantial advance in price of crude oil would justify modification of water-flooding policies so as to exploit the new possibilities for profitable operation which will be presented by the changed economic situation. A. H. N.

667. Patents on Production. N. E. Gunderson. U.S.P. 2,309,697, 2.2.43. Appl. 26.12.40. Well cleaning, especially well screens, by means of pumping.

W. J. Crites. U.S.P. 2,309,827, 2.2.43. Appl. 2.1.42. Deep-well pump and having a rotatable inner tubing and a stationary outer tubing.

J. E. Hall. U.S.P. 2,309,897, 2.2.43. Appl. 5.8.39. Pump for oil-wells using pressures transmitted from the surface to actuate the pump.

G. A. Rayner. U.S.P. 2,309,922, 2.2.43. Appl. 19.5.41. Well-swab.

E. E. Claytor. U.S.P. 2,309,935, 2.2.43. Appl. 19.6.41. Process for breaking petroleum emulsions using the salts of basic amines.

J. D. Andree. U.S.P. 2,311,504, 16.2.43. Appl. 14.5.40. Pump-jack having a walking beam and pull-rod.

L. Yost. U.S.P. 2,311,805, 23.2.43. Appl. 24.3.41. Closure for submersible pumping unit.

J. R. Collins. U.S.P. 2,311,816, 23.2.43. Appl. 27.6.41. Valve-spacer for pump-rods in well-pumping apparatus.

H. J. Pankratz. U.S.P. 2,311,863, 23.2.43. Appl. 6.12.41. Oil-well pumps using an outer tubing for transmitting gas under pressure into the well-bore.

R. M. Rhoads. U.S.P. 2,311,868, 23.2.43. Appl. 1.10.40. Apparatus for controlling the flow of fluids which increase in volume on pressure drop.

R. M. Rhoads. U.S.P. 2,311,869, 23.2.43. Appl. 1.10.40. Apparatus for controlling well production of expanding fluids.

E. J. Weatherby. U.S.P. 2,311,893, 23.2.43. Appl. 17.3.41. Well-pumping apparatus with a rotary prime mover disposed in the well.

F. G. Beckman. U.S.P. 2,312,018, 23.2.43. Appl. 19.8.39. Method of and means for cleaning wells by drilling and then applying high-pressure jets to remove loosened earth.

T. W. Adair. U.S.P. 2,312,228, 23.2.43. Appl. 5.12.38. Pump for wells consisting of a cylinder having a plurality of piston chambers.

A. Boynton. U.S.P. 2,312,315, 2.3.43. Appl. 8.12.39. Differential stage lift-flow device using side valves.

L. E. Hughes. U.S.P. 2,312,337, 2.3.43. Appl. 29.1.40. Hydraulic well-pump using liquid-operated motor and double-acting pump.

A. A. Jens. U.S.P. 2,312,415, 2.3.43. Appl. 12.10.40. Method of welding the ends of supporting rods to end fittings of well-screens.

L. M. Trawick. U.S.P. 2,312,455, 2.3.43. Appl. 3.9.40. Intermitting system for flowing wells.

H. O. Williams and A. A. Jens. U.S.P. 2,312,458, 2.3.43. Appl. 1.8.38. Method of making deep well screens.

H. O. Williams and A. A. Jens. U.S.P. 2,312,459, 2.3.43. Appl. 1.8.38. Method of making deep well screens.

A. J. Penick and K. T. Penick. U.S.P. 2,312,476, 2.3.43. Appl. 26.5.39. Well-head.

E. J. Roach and E. E. Cooke, Jr. U.S.P. 2,312,487, 2.3.43. Appl. 18.11.41. Well control-head for oil production.

R. A. Salathiel. U.S.P. 2,312,731, 2.3.43. Appl. 19.10.38. Process and agent for breaking petroleum emulsions.

R. A. Salathiel. U.S.P. 2,312,732, 2.3.43. Appl. 19.10.38. Process and agent for breaking petroleum emulsions.

R. A. Salathiel. U.S.P. 2,312,733, 2.3.43. Appl. 19.10.38. Process and agent for breaking petroleum emulsion.

R. A. Salathiel. U.S.P. 2,312,734, 2.3.43. Appl. 19.10.38. Process and agent for breaking petroleum emulsions.

R. A. Salathiel. U.S.P. 2,312,735, 2.3.43. Appl. 19.10.38. Process and agent for breaking petroleum emulsions.

G. A. Hatfield. U.S.P. 2,313,066, 9.3.43. Appl. 8.1.40. Gas-lift device for wells.

A. J. Penick and K. T. Penick. U.S.P. 2,313,169, 9.3.43. Appl. 9.5.40. Well-head assembly.

P. P. Shelby. U.S.P. 2,313,176, 9.3.43. Appl. 19.7.40. Well-tester.

F. J. Spang. U.S.P. 2,313,178, 9.3.43. Appl. 27.7.40. Plug for oil and gas wells.

L. Spencer. U.S.P. 2,313,369, 9.3.43. Appl. 28.2.40. Formation tester and gun perforator.

G. F. Turechek. U.S.P. 2,313,402, 9.3.43. Appl. 28.8.39. Bullet retainer means for gun perforators.

R. L. Midgett. U.S.P. 2,313,762, 16.3.43. Appl. 6.12.39. Automatic well test seal.

R. P. Miller. U.S.P. 2,313,836, 16.3.43. Appl. 15.7.39. Pump for deep well production.

J. B. Stone. U.S.P. 2,314,022, 16.3.43. Appl. 31.7.40. Treatment of wells with a demulsifier to prevent and break oil-and-acid emulsions.

A. T. Watson. U.S.P. 2,314,113, 16.3.43. Appl. 3.12.40. Gas lift oil-well pump intermitter.

W. L. Kitsman. U.S.P. 2,314,583, 23.3.43. Appl. 19.5.41. Well-pumping apparatus using a pair of reciprocating pumps.

A. Boynton. U.S.P. 2,315,496, 6.4.43. Appl. 28.11.38. Perforator for wells by means of abrasives.

L. A. Douglas. U.S.P. 2,315,694, 6.4.43. Appl. 10.6.41. **Means for testing subterranean strata for liquid and gaseous content.**

W. J. Crites. U.S.P. 2,315,841, 6.4.43. Appl. 12.5.41. **Well-pump having rotatable inner tubing.**

A. Arutunof. U.S.P. 2,315,917, 6.4.43. Appl. 30.9.37. **Submersible electric motor for deep well-pumps.**

R. C. Baker. U.S.P. 2,315,921, 6.4.43. Appl. 18.3.40. **Well-packer apparatus with a coupling means which can be disengaged.** A. H. N.

Cracking.

668. Catalytic Cracking. P. H. Faust. *Refiner*, February 1943, **22** (2), 45–48.—A brief discussion on catalysts leads to the conclusions that (1) a catalyst functions only as an accelerator of an already possible reaction; (2) the catalyst may exert its accelerating action among a group of reactions selectively; (3) in any individual reaction, the catalyst only hastens the attainment of equilibrium—it cannot shift the equilibrium. A simple theory of chemical reaction with catalysts is described and operating variables are discussed.

Thermal and catalytic cracking are compared by comparing their products. Catalytic results in a gasoline of superior octane rating to that of thermally cracked gasoline. While the production of highly branched compounds is perhaps the most notable achievement of catalytic cracking, there are other factors, such as sulphur reduction, aromatization, and desirable positions of chain splitting, that combine to add superiority to the yield of the catalytic unit. Catalytically cracked gasoline, by virtue of its low sulphur and gum contents, is the only cracked product that may be burned in aviation engines. In the gases, high ratios of *iso*butane to normal butane, and of the entire butane–butylene (" B–B ") cut to total gas, are features of special importance now, since they combine to make catalytic cracking an ideal source of charge-stock for both alkylation and butadiene plants.

Considering the economics of the catalytic *versus* thermal problem, the advantages of catalytic cracking must be weighed against its higher cost, both of construction and of operation, for the savings in construction of a low-temperature and pressure unit do not counterbalance the extra expense involved in equipment for handling the catalyst. A. H. N.

669. Patents on Cracking. C. L. Thomas. U.S.P. 2,308,792, 19.1.43. Appl. 16.1.41. To produce high anti-knock gasoline a hydrocarbon oil is subjected under cracking conditions to contact with an undried, finely powdered synthetic catalyst prepared by precipitating a finely powdered, hydrated silica from an alkaline silicate solution and mixing with it a hydrous oxide precipitated from a solution of a metal salt.

J. D. Seguy. U.S.P. 2,310,123, 2.2.43. Appl. 17.11.41. In a hydrocarbon conversion process cracked vapours are fractionated, also charging oil, to separate light gases, heavy, readily liquefiable gases, and gasoline, and to condense and separate light reflux condensate and heavy reflux condensate. Light and heavy reflux condensates are cracked, and resultant conversion products are passed to a reaction and separating zone in which cracked vapours are separated from liquid residuum. Part of the residuum is combined with the heavy liquefiable gases, and the mixture is fed to a reduced pressure vaporizing and separating zone. In this zone vapours are separated from non-vaporous residue. The vapours are cracked, and conversion products are fractionated to separate olefin-containing gases and gasoline. Heavy and light reflux condensates are combined with the corresponding fraction separated in the first fractionating operation. Olefin-containing gases are polymerized to form gasoline boiling polymers. Polymers heavier than gasoline are separated from the polymerization products and passed to the reduced pressure vaporizing and separating operation.

J. K. Roberts and M. T. Carpenter. U.S.P. 2,310,183, 2.2.43. Appl. 16.7.38. **Method of cracking hydrocarbon oils.**

C. W. Tyson and E. V. Murphie. U.S.P. 2,311,318, 16.2.43. Appl. 15.10.38. In a method of catalytic cracking of hydrocarbon oil to produce lower-boiling hydrocarbons the oil is first heated to vaporizing and reaction temperature. The resultant vapours are introduced into a reaction vessel provided with a number of horizontally extending catalyst beds arranged one above the other in spaced relation. Vapours are passed through certain catalyst beds in series.

Standard Oil Development Co. E.P. 552,731, 22.4.43. Appl. 12.9.40. Hydrocarbon oils boiling substantially within the gas-oil range are catalytically cracked in the presence of hydrogen in the following manner. The reaction is carried out in the presence of a solid catalyst at a temperature between 700° and 1000° F., under a pressure between atmospheric and 400 lb./sq. in., and in the presence of a gas containing between 20 and 90 mol. % of free hydrogen. The reaction is carried to a point shortly before that at which a consumption of free hydrogen begins, and is then discontinued. The catalyst is then regenerated for use in a subsequent cycle of operations.

Standard Oil Development Co. E.P. 552,880, 29.4.43. Appl. 21.5.41. The patent relates to the cracking of hydrocarbon oils to form lower-boiling motor-fuel products, and has particular reference to the cracking of hydrocarbon oil in the presence of a finely divided catalyst suspended in the oil which is to be cracked.

J. W. Teter. U.S.P. 2,312,681, 2.3.43. Appl. 19.2.41. In the production of gasoline, a charge of hydrocarbons is maintained substantially in vapour phase in a cycle of movement in a closed stream. Hydrocarbons to be processed and a conversion catalyst are introduced into the stream, and the catalyst is maintained in suspension by the velocity of movement in the cycle. After maintaining the circulating stream at a temperature between 950° and 1050° F. under a pressure of about 100 lb. per square inch for a minimum period of 15 seconds, a part of the suspended catalyst is selectively separated from the stream and removed from the cycle. Part of the stream of hydrocarbons and suspended catalyst is discharged from the cycle and spent catalyst, and a gasoline fraction is recovered from the discharged part.

A. C. Jessup. U.S.P. 2,313,241, 9.3.43. Appl. 16.11.39. In the cracking of an oil material, the oil is subjected to the action of hydrogen gas introduced as such, under a pressure of several atmospheres, while in the presence of freshly reduced iron in a copper apparatus. The process is continued until the sulphur content of the oil is substantially lowered, and until a substantial amount of low-boiling hydrocarbons has been produced.

J. F. Sturgeon. U.S.P. 2,315,024, 30.3.43. Appl. 8.9.39. In a process for cracking a hydrocarbon oil heavier than gasoline to produce a substantial yield of gasoline, the oil is subjected at a temperature between 850° and 1200° F. to contact with a catalytic material. This material is prepared by compositing a major proportion of precipitated silica hydrogel with a relatively smaller portion of another precipitated hydrogel selected from those of alumina, zirconia, and a mixture of alumina and zirconia, to form a hydrogel composite. The hydrogel composite is frozen and thawed to convert it into a powder and an aqueous solution. The powder is recovered, washed to remove water-soluble impurities, dried and calcined.

G. Egloff. U.S.P. 2,315,192, 30.3.43. Appl. 17.5.40. In a conversion process a hydrocarbon oil is subjected to catalytic cracking in admixture with a slurried catalyst in a primary zone. The conversion mixture is introduced into a vaporizing zone wherein vapours and gases are separated from residue. Vapours and gases are subjected to fractional condensation to form a relatively heavy reflux condensate, a lighter reflux condensate, gasoline distillate, and a normally gaseous product. The gasoline distillate is recovered. Normally gaseous products are combined with at least a portion of the lighter reflux condensate, and the mixture is catalytically cracked with a slurried catalyst in a second cracking zone. Resultant products are passed to the vaporizing zone. At least part of the heavy reflux condensate is cracked with a slurried catalyst in a third cracking zone, and the resultant products are passed to the vaporizing zone. H. B. M.

Hydrogenation.

670. Patents on Hydrogenation. Charles Weizmann. E.P. 552,115, 24.3.43. Appl. 12.7.40. Aromatic hydrocarbons having eight carbon atoms are prepared by passing butylene (C_4H_8) over a metallic hydrogenation and dehydrogenation catalyst at a temperature between 500° and 800° C., preferably at atmospheric pressure.

G. C. Connolly. U.S.P. 2,310,278, 9.2.43. Appl. 20.5.38. In a process for the destructive hydrogenation of hydrocarbon oils a mixture of the oil and hydrogen containing gas is passed through a hydrogenating zone, and while still in the zone it is contacted with a catalyst. The catalyst is a carrier composed of silica and alumina formed by impregnating silica hydrogel with a compound of aluminium convertible to the oxide, and thereafter converting the aluminium compound to the oxide. The carrier thus formed is impregnated with an active hydrogenating catalyst.

B. B. Corson and M. W. Cox. U.S.P. 2,311,979, 23.2.43. Appl. 15.3.40. Hydrocarbons are dehydrogenated by subjecting them at a temperature in the approximate range of 450–750° C. to the action of an alumina-chromia catalyst containing a sufficient quantity of an alkaline-earth metal oxide substantially to reduce the carbon-forming tendency of the catalyst at that temperature.

J. C. Morrell and A. V. Grosse. U.S.P. 2,313,162, 9.3.43. Appl. 25.3.39. Aliphatic hydrocarbons are dehydrogenated by contacting them under suitable conditions with an oxide of an element from the left-hand column of Group 5 of the Periodic Table, supported on an activated alumina consisting of a calcined aluminium hydrate of high adsorptive capacity. H. B. M.

Polymerization and Alkylation.

671. Patents on Polymerisation and Alkylation. Standard Oil Development Co. E.P. 552,196, 26.3.43. Appl. 24.9.41. Improvements in the process for production of normally liquid, branched-chain, paraffinic hydrocarbons by reacting at least one *iso*paraffin with at least one mono-olefin in the presence of concentrated sulphuric acid under alkylating reaction conditions are as follows. At least two alkylating zones are maintained in series; substantially different concentrations of sulphuric acid are maintained in each zone; into one of the zones is introduced at least one mono-olefin having a different degree of alkylation activity from the olefins introduced into other alkylation zones; olefin activity and acid concentration are so correlated that the olefin having the greatest degree of alkylating activity is in contact with the acid of lowest alkylating concentration; partly spent sulphuric acid from one zone is used in another zone utilizing acid of lower alkylating concentration.

Shell Development Co. E.P. 552,381, 5.4.43. Appl. 26.5.42. In a process for the production of motor fuel by alkylating an *iso*paraffin with a normally liquid olefin, a hydrocarbon mixture containing the olefin and the corresponding *iso*paraffin and normal paraffin is distilled to separate a fraction containing the *iso*paraffin and the olefin, but substantially free from the normal paraffin. The *iso*paraffin to be alkylated is reacted with the olefin in the separated fraction in the presence of an alkylation catalyst and a substantially *iso*paraffinic hydrocarbon product is recovered.

Phillips Petroleum Co. E.P. 552,413, 7.4.43. Appl. 29.3.40. In a catalytic process for the conversion of olefinic hydrocarbons having not more than five carbon atoms in the molecule into volatile olefin polymers with the minimum formation of high-boiling polymers, the olefinic hydrocarbon is passed through a contact zone containing a stationary solid polymerization catalyst. Pressure in this zone is sufficient to maintain the olefinic hydrocarbons in the liquid state, and temperature is such that volatile olefin polymers are formed, but not above the critical temperature of the olefinic hydrocarbons. In admixture with entering olefinic hydrocarbons, an untreated portion of olefin polymers formed in the contact zone is returned to this zone. The remaining portion is passed to a separating zone, where volatile olefin polymers are separated from it.

D. R. Carmody and E. L. D'Ouville. U.S.P. 2,308,560, 19.1.43. Appl. 30.12.39. An *iso*paraffinic hydrocarbon is converted into hydrocarbons of higher molecular

weight by alkylating the original material with at least one normally gaseous olefinic hydrocarbon in the presence of a catalyst consisting of a complex formed by the reaction of a hydrocarbon with an aluminium halide. The complex has a heat of hydrolysis between 60 and 75 large calories per gram atom of active aluminium.

R. F. Marschner and D. R. Carmody. U.S.P. 2,308,561, 19.1.43. Appl. 18.6.41. *Iso*paraffinic hydrocarbons are alkylated with olefinic hydrocarbons by contacting them with the olefinic hydrocarbons in the presence of a catalyst containing an aluminium–halide–paraffinic hydrocarbon complex having 23–32% by weight of bound hydrocarbons, and a hydrogen halide activator.

R. F. Marschner. U.S.P. 2,308,562, 19.1.43. Appl. 31.3.42. An aviation gasoline of high octane number and balanced volatility characteristics is obtained by contacting a low-boiling *iso*paraffinic hydrocarbon with a normally gaseous olefin in the presence of an aluminium halide–paraffinic hydrocarbon complex. By maintaining a mol ratio of normally gaseous olefin reacted to *iso*paraffin hydrocarbons present of at least 0·77 a mixture containing at least mono- and di-alkylates is obtained.

C. L. Thomas. U.S.P. 2,313,103, 9.3.43. Appl. 25.3.39. Hydrocarbons are synthesized by alkylating an *iso*paraffin with an olefin in the presence of fluorosulphonic acid. H. B. M.

Refining and Refinery Plant.

672. Refiners Shift into High in Quick Conversion Programme. H. D. Ralph. *Oil Gas J.*, 6.8.42, **41** (13), 12.—The present American refinery programme for production of war products is discussed from a non-technical viewpoint. 75% of the refining industry is reported to be contributing, and the latest developments include about 30 so-called nucleus plants and an increasing number of the smaller refineries. Whilst emphasis is laid upon butadiene and 100-octane gasoline, other essential products such as toluene, benzene, *iso*butylene, etc., are not being neglected. J. C.

673. Conversion of Refineries to War Producton Explained. H. S. Norman. *Oil Gas J.*, 6.8.42, **41** (13), 13.—A summary, made available by the report of the Petroleum Industry War Council's Committee on synthetic rubber, is given of the recommendations of the leaders of the American industry for the quick conversion of existing refineries for the production of maximum quantities of war materials. The main objective is the modification of existing facilities so as to produce sufficient codimer to satisfy all available hydrogenation equipment, the product to be used for 100 octane aviation gasoline. Methods of operation of U.O.P. and Kellogg–Polyco poly. plants for this purpose are dealt with briefly, and a short account is also given of methods for securing the elevated temperatures necessary for maximum yields of butadiene. The third important product is ethyl benzene for styrene to be combined with the butadiene for synthetic rubber. The recommendations also include provision for the use of ethyl alcohol derived from grain. J. C.

674. How to Break Piping Bottlenecks. G. W. Hauck. *Refiner*, February 1943. **22** (2), 33–38.—The development of steel and cast-iron flanges is discussed. The use of cast iron instead of steel makes available the lap joint for many services where this type of joint with its advantages is preferred. But an important cautionary note is necessary. Care must be exercised in bolting up any lap joint equipped with a cast-iron flange, in order to prevent breakage. Pipe fitters are accustomed to finding all lap joints with steel flanges, and they cannot apply extremely heavy bolt loads or sledge bolts when cast-iron flanges are employed. Several additional cautions are suggested: (1) cast-iron flanges should never be used on the ends of any type of expansion pipe bend. Such flanges, as well as those on the piping adjacent to the expansion pipe bends, should always be of steel, to preclude breakage. (2) Cast-iron flanges are not recommended for lines handling hazardous fluids, or where fire hazard legislates against their use. (3) Do not exceed code limitations concerning pressure and temperature in using cast-iron flanges.

Unions, valves, and several fittings are further discussed and suggestions made in order to conserve material and solve engineering problems with minimum experiment. A few simple substitutions are: a reducing screwed flange can often be made

by tapping a blind flange, either concentric or eccentric as desired. This is practical provided the tapped opening is not too large in pipe size to preclude a sufficient length of thread for a satisfactory pipe joint. A piece of plate, if available, can be fashioned into a slip-on welding flange, or a lap-joint flange if the thickness is increased, particularly in the latter, to compensate for the lack of hub. Similarly, a blind flange can be fabricated from steel plate. These are not recommended necessarily as good practice, but they are satisfactory in certain instances, especially in emergencies. Instead of a 4 × 3-in. screwed elbow required for an extension of a pipe-line during a shutdown, perhaps a 4 × 3 × 3-in. screwed tee with a 3-in. plug would answer the purpose. If this happened to be a flanged job, and the reducing fitting were not in stock, a straight fitting and a reducing flange might suffice. If it were a welded job and the reducing fitting unavailable, a straight fitting and a reducer might satisfy the need. Usually, the answer is in the affirmative. To-day the bushing comes into its own as never before. Many sizes of reducing screwed fittings have been eliminated, due to the simplification programme. At other times the desired reducing fitting may not be available. Use the nearest size of reducing fitting, or a straight fitting with bushings to break these bottlenecks. A. H. N.

675. **Compression Combined with Close Fractionation.** Anon. *Refiner*, February 1943, **22** (2), 39–43.—A new plant is described in which a variety of natural gasolines and liquefied petroleum products is being finished under controlled fractionation. This plant draws raw materials from an old field, which is stated to be submerged with the completion of a flood-control and hydro-electric project along the Washita and Red Rivers. Oil and gas are produced in the conventional manner. The gas is gathered from the separators and traps, and flows to the gasoline plant through a single large transmission line with only enough pressure held back by the regulators to dump the oil from the separators into the lease flow-tanks. The pressure on the plant field scrubber inside the yard averages approximately 2 inches of vacuum, but varying up or down from that pressure, depending on how well the flowing schedule is adhered to by the producers. The plant was built from a combination of used and new equipment. The old equipment, including the compressor units and the single high-pressure absorber, was removed from an idle plant formerly operated in the South Oklahoma City field. The equipment made especially for the Cumberland field plant includes the distillation unit, the four fractionators which are operated in series, and the pumps, reflux tanks and the commodity receivers. The plant is designed to operate as a combination compression and absorption project, operating at 300 lb. in the final stage of compression. This pressure is maintained so that a substantial percentage of the gasoline fractions can be obtained by the compression method and so that the residue above field and plant-fuel requirements can be introduced into a transmission system.

The major items of the plant are described. A. H. N.

676. **Formula for Determining Length of Pipe in a Reverse Bend.** Anon. *Refiner*, February 1943, **22** (2), 44.—A formula is derived for calculating the length of pipe in a reverse bend, and examples are worked out as illustrations of its use. A. H. N.

677. **Maintenance Kinks Prolong Motor Life.** E. Sterrett. *Refiner*, February 1943, **22** (2), 49–54.—The paper is a long discussion on correct maintenance, inspection, and other practices which may result in prolonging the lives of electric motors. A. H. N.

678. **The Stabilization of Crude Oil.** F. L. Kallam. *Refiner*, February 1943, **22** (2), 55–63.—The development of stabilization of crude oil is reviewed year by year from 1926 onwards. Apparently the record does not justify the claim that the oil industry is alert on technical advance. The paper will be concluded in further instalments, and 48 references to the literature are appended.

By 1936 the natural gasoline industry had already realized the advantages of stabilizing its gasoline before shipment and the fact that such operation actually results in an increase in production. In the same way, it is predicted that both the producer of crude oil and the pipe-line company will realize the advantages of stabil-

ized crude oil as a means of reducing evaporating losses in storage and transportation. Just how fast the industry will take up stabilization of crude oil is difficult to determine. It has already invested millions of dollars in vapour-saving devices for large storage tanks, so that stabilization is not so greatly needed as would have been the case had these investments not been made. There is no doubt that stabilization would result in a lower production of pentanes and heavier fractions in the gasoline plant, as these constituents would be retained to a greater extent in the crude oil. Since gasoline plants recover most of their production from field separators operating under 5 lb. pressure or less, the effect of stabilization would not be very great so long as the wells were produced by the conventional methods.

Stabilization of crude oil would call for large investments in fractionating towers and would add to lease operating costs. It is therefore improbable that the fractionation of crude in the field is apt to take place soon except on leases producing large quantities of high-gravity volatile oil, or in those districts where the oil is likely to be subjected to long periods of storage under hot-weather conditions. Disadvantages of stage separation for natural-gasoline manufacture are that both high- and low-pressure gathering systems are necessary in order to process the gas products from the separators. Although the gas volumes for low-pressure separators are usually so small that it is not economical to process them in a low-pressure gas-gathering system, they cannot generally be disregarded, on account of their high gasoline content. The use of stage separation does tend to decrease the amount of natural gasoline produced/brl. of oil, since the approach towards differential liberation of gas tends to hold a higher percentage of the gasoline in the crude oil. A. H. N.

679. Patents on Refining and Refinery Plant. W. F. Rollman and L. S. Bonnell. U.S.P. 2,309,540, 26.1.43. Appl. 17.2.40.—A reduced crude petroleum oil is coked by heating it to a temperature of about 900° F. and then feeding it in atomized form to a coking zone at a feed rate of 0·5 volume of cold oil per drum volume per hour. To the bottom of the coking zone is fed 20% by weight of steam at a temperature of 900° F. The vaporous product is withdrawn from the upper end of the coking zone and a spongy, dry coke from the lower end of the zone.

J. H. McCullough, E. R. Birkhimer and L. N. Leum. U.S.P. 2,309,651, 2.2.43. Appl. 13.2.41. Acidic organic compounds are removed from hydrocarbon oil by introducing an aliphatic alcohol containing less than 4 carbon atoms per molecule into a stream of the hydrocarbons. The oil stream is countercurrently contacted with a stream of an aqueous solution of an alkaline reagent in which the alcohol is more soluble than in the hydrocarbon oil. In this way the alkaline reagent will admix with the alcohol in the oil-stream and the mixture will act upon the oil-stream to remove acidic organic compounds.

W. A. Schulze and G. H. Short. U.S.P. 2,309,871, 2.2.43. Appl. 31.8.40. Carbonyl sulphide is removed from liquefied petroleum gases by passing the fluids after removal of hydrogen sulphide over a reagent consisting of a solid absorbent material impregnated with a primary amine.

W. T. Hancock. U.S.P. 2,310,630, 9.2.43. Appl. 13.1.41. In a process for refining petroleum oils, heated gasoline-containing cracked hydrocarbons are subjected to polymerization and polymerized hydrocarbons are continuously fractionated to produce a vaporous fraction containing hydrocarbons of the gasoline range and a liquid fraction having a boiling range higher than gasoline. The liquid fraction is then mixed with solvent petroleum oil having a higher boiling range, and afterwards vaporized and separated from the solvent oil to leave residual oil containing impurities removed from the hydrocarbons of the liquid fraction. A stream of the residual oil is re-circulated and admixed with the liquid fraction being produced by fractionation of polymerized hydrocarbons.

J. H. Carpenter, R. B. Kennedy and H. J. McClanahan. U.S.P. 2,310,837, 9.2.43. Appl. 18.9.41. In the fractional distillation of petroleum oil in the presence of steam and ammonia in a distillation zone to obtain overhead and bottoms the overhead is condensed in a condensing zone, fixed gas is separated in a separating zone, and a portion of the condensate is returned to the distillation zone as reflux for the distilling operation. An improvement comprises passing condensate from the condensing

zone to an enlarged settling zone where the condensate is held in a relatively quiescent state. Aqueous matter settled from the condensate is removed prior to passing it to the separating zone.

J. M. Barron. U.S.P. 2,310,922, 16.2.43. Appl. 18.2.41. In a hydrocarbon oil-conversion process crude petroleum is separately distilled to separate residual constituents from lighter components. Straight-run lighter components are cracked, and residual constituents from the crude petroleum are combined with hot cracked products. Afterwards the admixed products are converted to coke in a coking zone. Vapours from the coking zone are subjected to a primary dephlegmation to form a tarry condensate adapted for fuel oil. Dephlegmated vapours are fractionated to separate a reflux condensate from lighter products, and the condensate is afterwards subjected to thermal cracking. Resultant products are separated into vapours and residue, and the former are combined with vapours from the coking operation for subsequent fractionation.

P. V. Brower and L. Love. U.S.P. 2,311,328, 16.2.43. Appl. 6.11.41. In a sweetening process in which sour hydrocarbon distillate is treated with an aqueous alkaline plumbite solution and sulphur, an alkyl phenol concentration of 8–15 gr./litre is maintained in the plumbite solution.

J. T. Ward. U.S.P. 2,311,421, 16.2.43. Appl. 21.4.38. An apparatus is described suitable for heating hydrocarbon fluids to conversion temperature, and including a heating chamber, means for supplying heat thereto, and a row of spaced horizontally extending heater tubes arranged along a boundary surface of the heating chamber. Some of these heater tubes are spaced at greater distances from each other and from the boundary surface than the rest of the heater tubes in the row.

V. A. Kalichevsky, E. T. Scafe, and K. F. Hayden. U.S.P. 2,311,593, 16.2.43. Appl. 6.12.40. Sulphur constituents, such as elemental sulphur, hydrogen sulphide, and mercaptans, are removed from hydrocarbon oil fractions by contacting the oil with solid anhydrous alkali particles of colloidal sizes.

F. H. Bottomley. U.S.P. 2,312,020, 23.2.43. Appl. 18.12.40. In the refining of gasoline it is first treated by contacting it with an adsorbent clay at a relatively low temperature, to effect polymerization of unstable gum-forming constituents. Resulting polymers are separated from the gasoline, which is afterwards heat-treated to a temperature between 650° and 750° F. Finally the gasoline is contacted with adsorbent clay to effect desulphurization.

E. W. McNealy. U.S.P. 2,312,112, 23.2.43. Appl. 2.11.40. In a process in which a flowing stream of cracked petroleum oil is continuously contacted with an acid-treating agent, the addition of the treating agent is controlled in the following way. The differential temperature of the stream of oil is determined between two points in the stream, at least one of the points being beyond the point of contact of the stream with the acid treating agent and sufficiently beyond the other point to enable the measurement of a temperature rise in the stream resulting from the heat of reaction of the acid treating agent and the oil. Addition of the acid treating agent can thus be controlled in accordance with vibrations in this differential temperature.

K. Korpi. U.S.P. 2,312,560, 2.3.43. Appl. 2.3.40. In a conversion process hydrocarbons are heated to a temperature between 600° and 1000° F. for a sufficient length of time to effect the reaction, and in the presence of a catalyst prepared by adsorbing phosphoric acid on a carrier and afterwards neutralizing the acid with approximately one-sixth to two-thirds equivalents of a caustic alkali per mol. of the acid.

L. M. Henderson and G. W. Ayers. U.S.P. 2,312,820, 2.3.43. Appl. 14.3.41. During the removal of weakly acidic organic sulphur compounds from otherwise substantially neutral hydrocarbon fluids, the fluids are contacted with an aqueous alkaline solution containing a hydrolyzable salt of an unsubstituted organic acid having at least one carboxyl group attached to aliphatic carbon, but having one or more alkyl hydrogens replaced by halogen.

F. E. Frey. U.S.P. 2,314,040, 16.3.43. Appl. 6.10.32. In a process for the conversion of normally gaseous hydrocarbons into normally liquid hydrocarbons, the gaseous mixture containing butane, butene, propane, propylene, ethane, ethylene,

methane, and hydrogen is scrubbed with a liquid menstruum composed principally of hydrocarbons of three and four carbon atoms per molecule. In this way butanes, butenes, propane, propylene, ethane, and ethylene are separated from undissolved methane and hydrogen. Afterwards these are converted at elevated temperature to produce liquid oils.

F. E. Frey. U.S.P. 2,314,335, 23.3.43. Appl. 28.3.39. In a process for producing derivatives of paraffin hydrocarbons, a paraffin of the type CH_3Cl_3 is treated with an elementary halogen. In this way a substitution of halogen for hydrogen takes place forming isomeric alkyl halides. The halides so formed are treated at a temperature between 175° and 700° C. for a period of time such that olefins and hydrogen halide are formed and alkyl halides of the type CH_2XCR_3 are relatively unaffected. Olefins and hydrogen halide are separated from the products of this treatment.

R. P. Ferguson. U.S.P. 2,314,446, 23.3.43. Appl. 1.4.41. In the refining of petroleum oil the oil is treated with a mineral acid to remove objectionable compounds. The acid-treated oil is then heated in the presence of a colour adsorbent to a temperature between 350° and 650° F. The oil–clay mixture is maintained at this temperature for between 5 and 30 minutes, and an alkaline reagent is then added. Finally, the mixture is cooled and the colour adsorbent and alkaline reagent are separated from it.

A. B. Doran. U.S.P. 2,314,576, 23.3.43. Appl. 15.10.40. During desulphurization, a sulphur-containing oil is contacted with an adsorptive agent containing a compound of an acidic oxide of manganese in which the valence of the manganese is not more than four with a metal the sulphide of which is highly insoluble in the oil.

S. Pilat. U.S.P. 2,315,131, 30.3.43. Appl. 30.9.34. In a process for separating a hydrocarbon oil into fractions having different properties, the oil is subjected to the precipitating action of a quantity of gaseous hydrocarbon treating agent consisting substantially of at least one of the hydrocarbons having less than three carbon atoms per molecule. The precipitating action is exerted under a superatmospheric pressure below the condensation pressure of the gaseous treating agent. The quantity used is sufficient to cause the formation of two liquid oil-containing phases of different specific gravities.

K. M. Watson. U.S.P. 2,315,144, 30.3.43. Appl. 11.5.39. Hydrocarbon oil of relatively high sulphur content is improved by contacting it with a dehydrogenation catalyst under dehydrogenation conditions to form olefins and aromatics therein with the simultaneous production of hydrogen. Sulphur-containing dehydrogenated hydrocarbons are subjected to hydrogenation with hydrogen formed in the dehydrogenation process. In this way sulphur is converted into hydrogen sulphide and substantial saturation of olefins is effected.

W. A. Schulze. U.S.P. 2,315,662, 6.4.43. Appl. 7.6.41. Carbonyl sulphide is removed from hydrocarbon fluids essentially free of hydrogen sulphide and mercaptans by contacting the fluid with a solid reagent consisting of an adsorbent carrier impregnated with an aqueous solution of a soluble cadmium salt. The impregnating solution has a p_H between 8 and 14.

W. A. Schulze. U.S.P. 2,315,663, 6.4.43. Appl. 7.6.41. Carbonyl sulphide is removed from hydrocarbon fluids essentially free of hydrogen sulphide and mercaptans by contacting the fluid with a solid reagent comprising an adsorbent carrier impregnated with an aqueous solution of a soluble cupric salt. The impregnating solution has a p_H between 8 and 14. H. B. M.

Chemistry and Physics of Hydrocarbons.

680. Phase Behaviour of the Acetylene–Ethylene System. S. W. Churchill, W. G. Collamore, D. L. Katz. *Oil Gas J.*, 6.8.42, **41** (13), 33.—High-temperature cracking leads to hydrocarbon gases often rich in ethylene and containing appreciable quantities of acetylene. These gases, because of their high reactivity, are favoured as base stocks for many hydrocarbon products, and their behaviour is therefore of importance. The phase behaviour of mixtures of these gases has therefore been examined, and the data are presented in tabular and graphical form. With paraffin mixtures the critical

temperatures and pressures lie between or above those of the constituents. However, for acetylene/ethylene mixtures, curves of composition against critical loci, and isobaric diagrams of temperature plotted against composition for equilibrium vapour and liquid phases definitely establish the existence of azeotropic mixtures. Ethane/ethylene mixtures do not form such azeotropes, but ethane and acetylene do, suggesting that the acetylene is the primary cause of the formation of the constant-boiling mixtures.
J. C.

681.* **Properties of Normal Paraffins.** Part 1. L. Ivanovszky, A. V. Brancker. *Petroleum*, October 1942, **5** (10), 168.—Melting point is selected as the most accurately determinable and the most important property commercially of paraffin waxes, and is made the basis of a study of the relationship between melting point and molecular weight in the normal paraffin series. Specific gravity, refractive index, and aniline point are considered less suitable for such a purpose. In general, melting points of waxes follow the simple mixture rule, but only approximately when the molecular weights differ widely. The presence of *iso*paraffins accounts for some divergence from additivity which is dependent on all the hydrocarbons of the waxes belonging to a single homologous series.

The accuracy of the available melting-point and molecular-weight data for paraffins is considered critically, and the conclusion reached that much of the data does not correlate, whilst some is obviously wrong. Within the range of 19–29 carbon atoms 1 C atom corresponds approximately to $\pm$ 6° F. in melting point, $\pm$ 0·0013 in n_D at 90° C and $\pm$ 0·0025 in specific gravity at 90° C.

When melting point is plotted against molecular weight for *n*-paraffins, two smooth curves are obtained for odd and even numbers of carbon atoms which converge at about C_{32}, and the various formulæ which have been proposed to express this relationship are tabulated and examined. Among the formulæ studied are those of Merckel, of Moullins, of Etessam–Sawyer, of Ivanovszky–Brancker, and an earlier formula of Ivanovszky. It is shown that the formulæ of Ivanovszky–Brancker (derived from the simple assumption that the melting point/molecular weight curve is a hyperbola) and of Etessam-Sawyer lead to the identical result that T plotted against M is a straight line, if the formulæ are valid.

A comprehensive table is given of experimental values for melting points of *n*-paraffins and of the values deduced from the molecular weights using the various formulæ, but the applicability of the formulæ is considered and judged in a succeeding article.
J. C.

682.* **Properties of Normal Paraffins.** Part 2. L. Ivanovszky, A. V. Brancker. *Petroleum*, November 1942, **5** (11), 188.—The applicability of the various formulæ relating to melting point and molecular weight for the normal paraffins, in particular those of Ivanovszky and of Ivanovszky–Brancker, is tested against the available experimental data and the reliability of the latter critically examined. It is considered that with increasing molecular weights melting points trend towards a limit of 404–415° K., and paraffin hydrocarbons of about 23,000 molecular weight, produced by the Fischer–Tropsch synthesis, are stated to have melting points within this range. The phenomenon of alternation in properties of odd and even members of the paraffin series is discussed from the point of view of melting point. (The Ivanovszky formula gives two straight lines.) Heat of crystallization and entropy of crystallization each give two straight lines against number of C atoms, and odd and even members of the paraffin series apparently differ in crystalline character, but for the higher members the evidence appears questionable.

A short discussion of the constitution of wax-like hydrocarbons shows that there is a fair amount of evidence for the presence of *iso*paraffins in waxes. It is concluded that the present formulæ indicate either this possibility or the phenomenon of alternation in the paraffin series. Whilst the present formulæ reproduce experimental results fairly well, modifications in the values of the constants will be required as more accurate experimental data become available.
J. C.

683. **A Simple Apparatus for Small Scale Catalytic Hydrogenation.** C. R. Noller and M. R. Barusch. *Refiner*, February 1943, **22** (2), 64.—This is a reprint from a paper published in *Industrial Engineering Chemistry*, Industrial Edition, November 1942.
A. H. N.

684. Patent on Chemistry and Physics of Hydrocarbons. E. E. Claytor. U.S.P. 2,309,935, 2.2.43. Appl. 19.6.41.—Petroleum emulsions of the water-in-oil type are resolved by means of an emulsifier consisting of the salt of a basic amine. The amine salt is obtained from an alkylated naphthalene sulphonic acid in which at least one alkyl group substituted in the naphthalene nucleus contains between 3 and 10 carbon atoms, and a heat-polymerized basic hydroxyamine. H. B. M.

Analysis and Testing.

685. Determining the Specific Gravity of Gas by the Effusion Method. G. M. Stearns. *Oil Gas J.*, 17.12.42, **41** (32), 51.—The method is based on the law of effusion of gases which states that under like conditions of pressure and temperature two gases will flow through a small orifice at rates that are inversely proportional to the square roots of their respective specific gravities. The apparatus described is simple, convenient to handle, and portable, and allows a volume of air and an equal volume of gas to be driven, in turns, through a small opening, by means of identical water pressure. J. C.

686. Balance Method of Determining Specific Gravity of Natural Gas. G. M. Stearns. *Oil·Gas J.*, 24.12.42, **41** (33), 47.—The balance method described, although less convenient than the effusion method, gives more accurate results. It is dependent on a combination of Boyle's law and Archimedes' principle. The apparatus consists essentially of a bulb attached to a beam and counterbalanced with an adjustable weight, the beam being suspended on a frictionless support and fitted with a pointer. The whole is contained within an air-tight case fitted with a window and a manometer. Sufficient gas is introduced into the case so that its buoyant effect on the bulb causes the bulb just to balance the weight, and the gas pressure is measured. Exactly the same procedure is carried out with air, and the specific gravity is obtained from the formula S.G. $= \frac{Pa}{Pg}$, where Pa is the absolute pressure at which the beam balances in air and Pg the absolute pressure at which it balances in the gas. The method is considered capable of accuracy to three decimal places. J. C.

687.* Equipment for Viscosity Measurement. L. A. Steiner. *Petroleum*, April 1943, **6** (4), 50–53.—The accuracy and precision of capillary viscometers are discussed on the basis of experimental results obtained with a number of calibrations and checking of such instruments. Both types of errors, systematic and irregular errors, are detected and discussed. Certain viscometers had a precision of 0·02%, others were very much poorer. The fact that a tube complies with specified dimension and has no visible defects is no guarantee of its proper working. Selected viscometers calibrated in their whole range are, however, well capable of producing figures within the accuracy requirements of the " standard methods " of the Institute of Petroleum or of the American Society for Testing Materials.

Five types of viscometers are discussed, and at the end of the paper they are compared. The suspended level viscometer is free from any necessity of adjustment of volume, and if the level chamber has a proper form, efflux times can be repeated with excellent accuracy without any particular skill. The wall of the top bulb retains, however, a different amount of oil according to whether the efflux time is short or long. Because of its three limbs, the probability of breakage is larger, and the percentage of breakages comparatively high unless cemented into fittings. Errors due to misalignment are comparatively small, but tend to make viscosity figures lower than the correct figure. The " Fenske " viscometer is charged in such a way that the filling error is small, but there is no possibility of checking up whether or not it is charged properly. The oil drains from the walls for quite a long time, thus changing the level in the bottom bulb. The calibration constant varies with temperature—consequently much skill and patience are necessary to calibrate accurately for the whole range. Errors due to faulty alignment are negligible. The viscometer combines speed, medium accuracy, and easy handling.

The U-tube is less affected by impurities than the two other types, and enables supervision of correct volume, the adjustment of which requires a certain amount of

skill. Influence of faulty alignment may be reduced to a negligible amount by proper fittings. It is a comparatively slow instrument if accuracy is required. The French standard viscometer has interchangeable capillaries which can be inspected and tested for themselves. The position of the actual level has to be read on a scale, and the accuracy is therefore limited. Otherwise it is extremely simple, quick, easy to handle, and to clean. The Danish viscometer incorporates two measuring ranges in a single instrument. The level adjustment is quick; accuracy is, however, limited for the same reasons as with the French method. A. H. N.

Motor Fuels.

688. **Patents on Motor Fuels.** Standard Oil Development Co. E.P. 551,961, 17.3.43. Appl. 28.11.41.—Isomerization of normal paraffins to *iso*paraffins is carried out in the presence of one halo sulphonic acid. Free or elemental hydrogen and also boron halide may be employed. Chlorsulphonic acid, fluorsulphonic acid, and bromsulphonic acid are examples of suitable catalysts for the process. The boron trihalide promoter may be either boron trichloride or boron trifluoride, or a mixture of these two halides. The process is useful for the isomerization of a large variety of feed-stocks, including normal butane, normal pentane, normal octane, and the higher straight-chain paraffinic homologues.

International Catalytic Oil Processes Corp. E.P. 552,372, 5.4.43. Appl. 28.8.41. High-octane-number motor fuel is produced by heating a thermally cracked naphtha having an end-point below 450° F. to a temperature of 850–1100° F. and contacting it with a catalyst comprising silica and an oxide of a metal of the group consisting of aluminium, magnesium, copper, beryllium, and thorium. The reaction is carried out at a pressure of from atmospheric to 200 lb. per sq. in. and under a space velocity of 4 to 60 volumes of liquid naphtha per volume of catalyst per space hour. In this way a volume-% yield within the range 94 to 99% is obtained.

O. A. von Smekal and M. A. Pokorova. E.P. 552,420, 7.4.43. Appl. 5.8.41. A process is described for the production of spirit suitable for use in internal-combustion engines from tar, tar oils, tar residuums, oil residuums, and the like. The original material is mixed with air which has been subjected to the action of an electric discharge, such as an electric spark, and afterwards it is submitted in the form of a fine mist and in separate successive quantities or puffs, to the action of heat, *e.g.*, by contact with a heated surface.

O. A. von Smekal and M. A. Pokorova. E.P. 552,422, 7.4.43. Appl. 5.8.41. A suitable apparatus for the production of spirit for use in internal-combustion engines from tar, tar oils, tar residuums, oil residuums, etc., is described.

W. J. Sweeney. U.S.P. 2,310,327, 9.2.43. Appl. 28.10.39. Gasoline of low acid heat and high-octane-number lead response is produced as follows. The oil to be converted is passed through a cracking zone containing an active cracking catalyst to convert a substantial part of it into motor-fuel constituents. Afterwards a light naphtha fraction is separated from the cracked products. This is substantially free of aromatic constituents and contains a substantial amount of olefinic constituents having a high acid heat. The fraction thus segregated is passed in a mixture with *iso*paraffins in contact with an active alkylating catalyst capable of accelerating the union between *iso*paraffins and olefins to form a saturated product.

W. H. Smyers and T. Cross, Jr. U.S.P. 2,310,376, 9.2.43. Appl. 15.8.36. Liquid fuel for internal-combustion engines of the Otto cycle multi-cylinder type is prepared by mixing hydrocarbons of such varying volatility and forming such varying air–fuel ratios as to cause material variation in knocking tendency of the several cylinders in operation. The fuel also contains a small quantity of a mixture of volatile lead alkyls consisting of tetra ethyl lead, triethyl methyl lead, diethyl dimethyl lead, ethyl trimethyl lead, and tetra methyl lead. In this way variation in cylinder knocking is eliminated and the anti-knock value of the fuel is raised.

K. M. Watson. U.S.P. 2,311,273, 16.2.43. Appl. 6.4.40. In a hydrocarbon oil-conversion process a bed of freshly reactivated cracking catalyst is maintained in the temperature range 750–850° F. During the processing period a stream of hydrocarbons heated to a temperature between 900° and 1050° F. is continuously passed through

this bed. At the beginning the catalyst is maintained at a relatively low conversion temperature to produce a substantially saturated gasoline. Afterwards it is kept at a higher conversion temperature to produce an unsaturated gasoline. Substantially unsaturated gasoline and saturated gasoline are collected separately.

A. Voorhies. U.S.P. 2,311,498, 16.2.43. Appl. 16.9.39. The net heat of combustion of an aviation fuel containing between 20% and 55% of aromatic hydrocarbons is increased to at least 18,500 B.t.u. per pound without substantially affecting the octane number of the fuel, in the following way. A sufficient quantity of a hydrocarbon having an octane number at least equal to the fuel and a hydrogen content in excess of 13·5% is added to the fuel to bring the hydrogen content of the mixture to at least 13·5%.

T. H. Risk, L. M. Henderson and A. B. Wilder. U.S.P. 2,312,360, 2.3.43. Appl. 15.12.39. A motor fuel consists of a base stock of saturated hydrocarbons boiling above 140° F. but within the gasoline range, and between 5% and 25% by volume of an addition agent. The addition agent consists of olefinic hydrocarbons boiling within the range 100–140° F. and having an octane blending value not less than 110. The octane number of the base stock is such that the addition agent and base stock will produce a final motor fuel of not less than 70 octane number.

S. S. Allender. U.S.P. 2,314,435, 23.3.43. Appl. 18.12.39. In the production of gasoline from a butane fraction containing *iso*butane and normal butane, the original material is fractionally distilled to separate *iso*butane and normal butane. A portion of the normal butane is isomerized to form a mixture containing essentially *iso*butane and normal butane. The mixture is passed back to the butane fractional distillation process to separate *iso*butane and normal butane. The remainder of the normal butane is dehydrogenated to produce a product consisting of normal butane, butenes, 3-carbon atom hydrocarbons, and lighter gases. The dehydrogenation product is separated into a butane–butene fraction and a mixture of 3-carbon atom hydrocarbons and lighter gases. Total *iso*butane obtained from the original butane mixture and from the isomerization is subjected to alkylation with normal butenes contained in the butane–butene fraction to produce a mixture of alkylation products and unconverted butanes. The mixture is returned to the original butane fractional distillation to separate *iso*butane, normal butane, and a substantially saturated alkylate, and to furnish a refluxing medium for the fractional distillation of the butane fraction.

R. E. Schaad. U.S.P. 2,314,460, 23.3.43. Appl. 29.3.39. To produce saturated hydrocarbons boiling within the gasoline range and of high anti-knock value, normally gaseous olefins are subjected to polymerization to form hydrocarbons of 6 or more carbon atoms to the molecule. C_6 hydrocarbons are separated from heavier polymers, and the latter are depolymerized to form olefins of less than 6 carbon atoms to the molecule. These are subjected to interpolymerization independently of the normally gaseous olefins to form mixed olefin polymers. At least a portion of these mixed polymers and the C_6 hydrocarbons are hydrogenated to effect substantial saturation.

P. Millar and G. H. Cloud. U.S.P. 2,316,011, 6.4.43. Appl. 28.10.39. A fuel for internal-combustion engines is prepared by adding 0·2 to 3% of a thiazole to a hydrocarbon oil boiling above the gasoline boiling range.

P. Millar. U.S.P. 2,316,012, 6.4.43. Appl. 28.12.39. To improve octane number of a hydrocarbon motor fuel, at least 1% by volume of a ketonic compound boiling in the boiling range of the fuel is added. The ketonic compound has the formula $R{\cdot}CO{\cdot}R^1{\cdot}CO{\cdot}R^2$. R^1 and R^2 are terminal organic groups, and R^1 represents an aliphatic hydrocarbon radical separating carbon atoms linked to oxygen. Each oxygen atom is bound to only one carbon atom. The fuel is free from substantial amounts of any other oxygen-containing organic compounds. H. B. M.

Gas, Diesel, and Fuel Oils.

689. Patents on Gas, Diesel, and Fuel Oils. P. Miller and E. Lieber. U.S.P. 2,310,306, 9.2.43. Appl. 10.10.39. Prior to ignition in a compression-ignition engine a diesel hydrocarbon fuel is contacted with solid free sulphur to mix with it a substantial ignition improving amount of free sulphur.

F. Schick. U.S.P. 2,310,812, 9.2.43. Appl. 6.7.38. Oils of high stability are prepared by blending a hydrocarbon oil of predominantly aliphatic character and relatively rich in saturated hydrocarbon components with at least 10% of a hydrocarbon oil of predominantly aliphatic character, and containing a substantially smaller amount of saturated hydrocarbons. The two oils have similar boiling ranges, and are members of the group consisting of diesel fuel oils and lubricating oils. After blending, the oils are contacted with a small amount of a chemical precipitating agent.

E. W. Fuller and E. M. Nygaard. U.S.P. 2,314,137, 16.3.43. Appl. 30.10.40. The ignition quality of a diesel fuel is improved by the addition of between 0·1% and 5% of an organic hydroxylamine, consisting only of carbon, hydrogen, oxygen, and nitrogen. H. B. M.

Lubricants and Lubrication.

690. The Lubrication by Thin Metallic Films and the Action of Bearing Metals. F. P. Bowden and D. Tabor. *J. Appl. Phys.*, March 1943, **14** (3), 141–151.—An investigation has been made of the rôle of thin metallic films in reducing the friction and wear between metal surfaces. It is shown that with metallic films possessing suitable mechanical and surface properties, the coefficient of friction is very low, and may be similar to that observed on ice. In many cases the behaviour of these thin metallic films resembles that of ordinary lubricants, except that Amonton's law is not obeyed. From experiments on alloys it is concluded that the frictional behaviour of a copper–lead alloy closely resembles that of a copper surface on which a very thin film of lead has been deposited. The actual value of the friction of the allow is the same as that of a copper surface on which a lead film 10^{-6} cm. thick has been artificially deposited. The temperature coefficient of friction is the same in each case. The increase in friction with wear is also very similar, except that in the case of the alloy there is evidence that the potential supply of lead is greater, since it may continue to be expressed from the alloy during the sliding process. With a thin film of lead deposited on copper the supply is, of course, limited to the amount actually present on the surface at the beginning of sliding.

These results show the important part which may be played by thin surface films of metal in reducing the friction and wear of bearing alloys, and support the view that in certain bearing alloys the anti-frictional and anti-seizure properties may be primarily due to the spreading of thin films of the soft, low-melting constituent, over the surface of the harder constituent. In this connection the importance of surface tension is apparent. The soft, low-melting constituent must spread readily on the harder one to form a thin film. This is borne out by experiment. It was shown, for example, with lead, indium, and mercury films on steel, copper, and silver, that unless the soft metal readily wetted the harder one, it was, under severe conditions of sliding, relatively ineffective as a lubricant. Although it is desirable that these metallic films should adhere to and wet the substrate, the converse should be true about the other moving surface—*e.g.*, the journal of a bearing. Provided the metallic film does not break down, the smaller the adhesion and the less the tendency of the metallic film to spread on to this surface the better. As was pointed out in the first paper, one important function of a lubricant is to reduce the adhesion between the two moving surfaces and help to reduce the effective shear strengths of the metallic junctions. A. H. N.

691. The Use of a Model Engine for Testing Internal Combustion Engine Lubricants. H. A. Cheetham and T. G. Hunter. *Min. and Pet. Tech. Mag.* (University of Birmingham), 1943, 32.—The engine test of an oil is a long and expensive process, chiefly because of the high initial cost of the test unit and the large amount both of fuel and lubricant consumed during the runs. It was therefore thought that it might be possible to use a model engine to test the performance of the oil and keep the cost of such tests to a relatively low figure. An added advantage of the method was that small quantities of oil could be tested, such as laboratory prepared synthetic samples. In order to test these assumptions a series of experiments was conducted on a small engine designed for model motor-boat propulsion. The engine had to be modified in order to render it fit for experimental work of a quantitative nature. Both these modifications and the experiments undertaken are described. The general

conclusion is that the method for testing oils appears capable of giving satisfactory results. A. H. N.

692. Patents on Lubricants and Lubrication. Imperial Chemical Industries. E.P. 552,123, 24.3.43. Appl. 19.9.41. Deterioration in colour of petroleum oils is inhibited by incorporating in the oils a condensation product of one molecular proportion of an aliphatic polyamine containing two primary amine groups with from three to ten molecular proportions of an aliphatic aldehyde with at least three carbon atoms. The α-carbon atom has at least one hydrogen atom attached. It is intended that petroleum oils should include fuel oils, oils used in heat-transfer apparatus, electrical transformers, and greases, as well as the usual lubricating oils. Non-viscous oils, such as gasoline and kerosine, are not covered by the patent.

H. S. Chase and G. C. Gaine. U.S.P. 2,308,490, 19.1.43. Appl. 17.1.36. Lubricating oil is recovered from a normally liquid hydrocarbon mixture containing relatively light lubricating components and lighter diluent components by fractionally distilling the mixture. The yield of relatively light lubricating-oil stock is increased by conducting the fractional distillation in the presence of a small proportion of heavy lubricating-oil stock.

B. B. Farrington, J. O. Clayton, and D. E. Etzler. U.S.P. 2,308,502, 19.1.43. Appl. 2.8.40. Preparation of a lubricant consisting of a major proportion of a hydrocarbon lubricating oil and 0·1–2% by weight of a metal alkyl monocarboxylate having an alkyl hydroxy group no more than three carbon atoms removed from a carbonyl group of the carboxylate.

H. M. Fraser. U.S.P. 2,308,599, 19.1.43. Appl. 25.7.40. Preparation of a lubricant having incorporated in it a lead soap of a hydroxy-stearic acid.

B. H. Lincoln and G. D. Byrkit. U.S.P. 2,308,622, 19.1.43. Appl. 9.3.39. A lubricant is prepared by admixing with at least 90% mineral lubricating oil a small proportion of a halogenated polyarylated aliphatic compound having at least a portion of the halogen on the aliphatic group.

E. C. Hughes. U.S.P. 2,308,690, 19.1.43. Appl. 23.11.40. Preparation of a lubricant consisting of a mineral oil of lubricating viscosity and a small amount of tolidine.

E. C. Hughes. U.S.P. 2,308,691, 19.1.43. Appl. 25.11.40. Preparation of a lubricant consisting of a mineral oil of lubricating viscosity and a small amount of 4-aminodiphenylamine.

P. Miller and E. Lieber. U.S.P. 2,310,305, 9.2.43. Appl. 31.12.37. The quality of a lubricating oil is maintained during service by circulating at least part of it through an addition agent reservoir containing a supply of slightly oil-soluble improving agent in undissolved form having oxidation inhibiting properties.

B. H. Lincoln and W. L. Steiner. U.S.P. 2,310,721, 16.2.43. Appl. 29.2.40. From 0·001% to 1% by weight of ethyl abietate and 0·5–10% by weight of a chlorinated compound are added to a lubricant to produce a stabilized high-film-strength lubricating oil.

C. F. Prutton. U.S.P. 2,310,993, 16.2.43. Appl. 1.7.37. Preparation of a lubricant consisting of a petroleum lubricating oil, a calcium soap of an aromatic stearic acid, and a separate halogen-bearing organic compound.

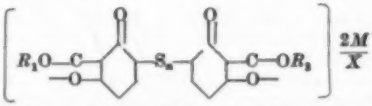
H. W. Ritchey. U.S.P. 2,311,305, 16.2.43. Appl. 6.5.40. Mineral lubricating oil for severe service internal-combustion engines is prepared by heating a mineral oil to an incipient cracking temperature in the presence of phosphorus. In this way phosphorus is caused to enter the hydrogen molecule. Afterwards the phosphorized oil is oxidized under controlled temperature conditions to yield phosphoric acids in the oil.

Z. C. Zimmer and G. M. McNulty. U.S.P. 2,311,500, 16.2.43. Appl. 8.5.40. An extreme-pressure lubricant consists of a lubricating oil and a small but effective amount of an oil-soluble condensation product of sodium mercaptide and a chlorinated solvent extract of petroleum hydrocarbons containing between 10% and 50% chlorine.

The Atlantic Refining Co. E.P. 552,732, 22.4.43. Appl. 23.4.41. To improve resistance to oxidation and enhance lubricating characteristics a small quantity of a mixed ester of a phosphorous acid containing at least one and not more than two alkylaroxyalkyl radicals is added to a lubricating oil base.

Standard Oil Development Co. E.P. 553,140, 10.5.43. Appl. 3.11.41. A lubricant is prepared from a waxy mineral lubricating oil, a small amount of a synthetic pour depressor and a small amount of a natural pour sensitizer extracted from a spent clay used for treating petroleum lubricating-oil stock.

E. W. Cook and W. D. Thomas, Jr. U.S.P. 2,311,931, 23.2.43. Appl. 27.12.41. A small proportion of a compound of the following general formula is added to a lubricating oil :—



R_1 and R_2 are members of the group consisting of alkyl and *cyclo*alkyl radicals having 4 or more carbon atoms, n is a positive integer and not more than 2, M is a metal radical and X is the valence of M.

J. O. Clayton and B. B. Farrington. U.S.P. 2,312,207, 23.2.43. Appl. 12.4.41. A lubricant is prepared by adding at least 0·05% by weight of a salt of an organic-substituted arsenic compound to a hydrocarbon oil.

J. O. Clayton and B. B. Farrington. U.S.P. 2,312,208, 23.2.43. Appl. 12.4.41. At least 0·05% by weight of a salt of a substituted acid of boron containing an organic constituent is added to a hydrocarbon oil.

W. P. Tighe. U.S.P. 2,314,530, 23.3.43. Appl. 18.5.40. Anti-welding lubricants are prepared by providing in a mineral oil non-adsorbable sulphur compounds. The oil is subjected to the action of sulphur and heat and air until several per cent. of sulphur are taken up. Afterwards it is acidified, and adsorbable compounds are eliminated by subjecting it to the action of a finely divided adsorbent material at a temperature somewhat in excess of the boiling point of water.

A. W. Burwell. U.S.P. 2,314,769, 23.3.43. Appl. 7.6.41. An improved lubricity-increasing agent for use in oils consists of a mixture of low-molecular-weight aliphatic alcohol esters of relatively high molecular weight, saturated aliphatic carboxylic acids of mineral origin, and a minor proportion of lithium soaps of these acids. The acid number of the mixture does not exceed 2, and the final product is substantially non-corrosive to aluminium, magnesium, and alloys thereof.

C. M. Loane and J. W. Gaynor. U.S.P. 2,316,078, 6.4.43. Appl. 24.3.41. A lubricant consists of a hydrocarbon oil and a small amount of the phosphorus and sulphur-containing chlorine-free reaction product of a phosphorus sulphide and a polymer having a molecular weight above about 500 of a mono-olefinic hydrocarbon of less than 6 carbon atoms.

C. M. Loane and J. W. Gaynor. U.S.P. 2,316,079, 6.4.43. Appl. 24.3.41. Added to a mineral oil is a small amount of the product obtained by heating at a temperature above 200° F. an *iso*butylene polymer with an alkali metal hydroxide dispersed therein.

C. M. Loane and J. W. Gaynor. U.S.P. 2,316,080, 6.4.43. Appl. 24.3.41. An improved lubricant consists of a lubricating oil and a small amount of a phosphorus and sulphur-containing phosphorus–sulphide–olefin polymer reaction product having at least a portion of its titratable acidity reduced by reaction with a basic reagent.

C. M. Loane and J. W. Gaynor. U.S.P. 2,316,081, 6.4.43. Appl. 24.3.41. A lubricant is prepared from a mineral lubricating oil and a small amount of a neutralized phosphorus and sulphur-containing reaction product of a phosphorus sulphide and an aromatic hydrocarbon.

C. M. Loane and J. W. Gaynor. U.S.P. 2,316,082, 6.4.43. Appl. 24.3.41. A lubricant is prepared from a mineral lubricating oil and a minor amount of a neutralized phosphorus and sulphur-containing reaction product of a phosphorus sulphide

and a hydrocarbon obtained by reacting a phosphorus sulphide with a hydrocarbon and subsequently neutralizing the reaction product with a basic reagent.

C. M. Loane and J. W. Gaynor. U.S.P. 2,316,083, 6.4.43. Appl. 24.3.41. A lubricant is prepared from a hydrocarbon lubricating oil and a small amount of the product obtained by reacting a phosphorus sulphide with a hydrocarbon, neutralizing with a basic reagent, and subsequently treating the reaction product at a temperature above 100° F. with a compound having an active hydrogen atom to obtain a product having a substantially lower sulphur content than the initial reaction product.

H. B. M.

Asphalt and Bitumen.

693. Bitumen Emulsions. Anon. *Paint Technology*, February 1943, **8** (86), 18.—B.P. 514,818 granted to Colas Products, Ltd., covers the production of bituminous emulsion paints suitable for colouring road surfaces, especially concrete, and for camouflage purposes by pigmenting 10–12% dispersions of bitumen with pigments, using bentonite as suspending agent. The basic emulsion is prepared from 55 parts of 200 pen. Venezuelan bituman, 45 parts of a solution containing 2% casein, and 0·35% KOH. A typical paint is produced by diluting 22 parts of emulsion with 78 parts of water, stirring in 3 parts of bentonite, 2 parts of iron oxide, and 1 part of a 20% solution of aluminium sulphate. The high pigment bitumen ratio is required to give obliteration, but covering power is good—200–300 gm. per sq. metre. Another basic emulsion from 55 parts albino bitumen emulsified in 45 parts of the alkali caseinate solution can be diluted and pigmented as above. Using chromium oxide green as pigment, paints are produced suitable for reconditioning brick and concrete surfaces such as those of tennis-courts.

B.P. 515,198 granted to Deutsche Erdöl-Akt-Ges. of Berlin-Schöneberg covers the production of stable, quick-breaking emulsions from "unsaturated" bitumens, produced by removing from the bitumens saturated oily constituents and materials insoluble in chloroform. Emulsibility is indicated by high iodine value, high solubility in aniline, and insolubility or low solubility in petroleum ether. Suitable products are cracked asphalts from brown coal-tar oils, Esthonian shale low-temperature distillation tar pitches and selective asphalts from phenol extracts of brown coal-tar. The emulsion gives glossy, compact, adherent, non-sticky, and completely weather-resistant films. The best results are obtained by diluting a 40–60% emulsion to 10–20%, using resin soaps, and removing coarse particles (above 5 μ) which separate on standing by centrifuging.

C. L. G.

694. Patents on Asphalt and Bitumen. E.I. Du Pont de Nemours. E.P. 552,500, 12.4.43. Appl. 8.9.41. To obviate the disadvantages of certain asphaltic or bituminous materials and dyes and organic pigments soluble or partly soluble in organic solvents, which tend to exhibit the phenomenon known as "bleeding" when additional organic coatings are applied an intermediate sealing coat is applied before the finishing surface. The intermediate sealing coat comprises an organic film-forming vehicle and uncharged activated carbon.

O. K. Schmied. U.S.P. 2,310,712, 9.2.43. Appl. 8.6.40. A shipping container for a block of asphalt consists of an outer casing, an inner lining of foil, and a continuous strippable plastic film on the foil. The foil is stuck to the casing by a bond of substantial strength, and the film is adhered to the foil by a bond of less strength. The film adheres to the block of material more strongly than to the foil, and on removal of the block the film clings to the surface of the material, which is removed in its entirety from the surface of the foil.

R. C. Hawks and E. M. Skinner. U.S.P. 2,311,389, 16.2.43. Appl. 31.7.41. An apparatus for reducing molten asphalt to small pieces embodies an elongated sloping fluid channel sharply constricted transversely at the lower end, means to supply a smooth stream of cooling fluid to the upper end of the channel, and a device to discharge on this stream a number of horizontally spaced streams of molten asphalt. The channel is of sufficient length below the asphalt supply device to allow the molten asphalt to become brittle by cooling through heat exchange with the cooling fluid before it reaches the constricted portion of the channel.

S. S. Sorem and A. P. Anderson. U.S.P. 2,313,596, 9.3.43. Appl. 10.6.40. An unemulsified asphalt composition capable of forming a durable bond with galvanized-iron surfaces consists of asphalt and an amount of a finely divided material chosen from the group consisting of zinc, zinc oxide, lead, lead oxide, lead hydroxide, and aluminium hydroxide in excess of that required to neutralize asphaltic acids formed by oxidation of the asphalt. The product is non-corrosive for prolonged periods of time.

P. E. McCoy. U.S.P. 2,313,759, 16.3.43. Appl. 7.8.39. A bituminous composition is prepared from a mineral hydrophilic substance and a bituminous material free from added saponifiable and saponified material in the following way. The mineral hydrophilic substance is coated with the bituminous material, and adhesion of the bitumen is improved by dispersing in it a relatively water-soluble and oil-soluble heavy metal salt. The hardness of the bituminous material is not substantially affected by addition of the salt.

D. E. Carr and H. W. Ritchey. U.S.P. 2,314,124, 16.3.43. Appl. 16.6.39. A relatively non-photosensitive asphalt is prepared by mixing with a relatively photo-sensitive asphalt an organic aliphatic inhibitor of photo-oxidation. The inhibitor is characterized by a long hydrocarbon chain terminating in an oxygenated group. The asphalt forms a rust when a layer 0·025 inch thick is exposed to the light of a 1500-watt lamp at a distance of about 6 inches from the lamp for a period between 8 and 32 hours, and is subsequently immersed in a bath of water at approximately 140° F. H. B. M.

Special Products.

695. Chemicals from Petroleum–Styrene. W. T. Ziegenhain. *Oil Gas J.*, 6.8.42, **41** (13), 37.—A short account of the production of styrene by the reaction of benzene with either ethylene or ethyl alcohol, followed by dehydrogenation. Physical properties of styrene are quoted, and the suggestion made that because of its high octane number its production on an increasing scale is warranted, apart from its war-time use for manufacture of Buna S. J. C.

696. Insecticide Specifications. Anon. *Soap*, December 1942, **18** (12), 129.—New U.S. Federal specifications have been drawn up covering petroleum distillate base liquid insecticide (fly spray) 0–1–541, and liquid insecticide (household) 0–1–546, for Government use from 18th March, 1943. The former allows the use of any toxic product, the required knockdown being not less than 2% below the Official Test Insecticide and the required kill not less than 16% above the O.T.I. The latter specifies the inclusion of at least 0·15% of pyrethrin I, with the normally accompanying amount of pyrethrin II, and allows the addition of any other ingredients required to bring the toxicity up to the above standard. Full details of the specification and methods of sampling, inspection, and test are given. C. L. G.

697. Drying Oils and Resins from Chlorinated Paraffins. Anon. *Paint Technology*, February 1943, **8** (86), 27.—According to B.P. 524,521 (J. W. C. Crawford, S. W. George, and I.C.I., Ltd.), hard-air-drying or stoving-paint films can be obtained from the condensation of olefins, derived by dehydrohalogenating chlorinated paraffins and malic, maleic, citraconic, glutaconic, or aconitic acids or anhydrides. The condensates can be esterified by heating with alcohols in the presence of strong mineral acid and modified esters produced by adding stearic, oleic, linoleic, etc., acids before or during esterification. The air-dried films are stated to be as hard as those of a copal varnish and the baked films as hard as store enamel. A method of preparing suitable olefins is described in B.P. 505,898. Esterification with monohydric alcohols gives soluble products, whereas with polyhydric alcohols resinous or rubber-like products, insoluble in the usual solvents, can be obtained by prolonged heating. Such products are useful in sealing or plastic compositions. If the olefins contain more than 21 carbon atoms per molecule, the esterification products require baking to give a satisfactory drying film, though some improvement in air-drying characteristics is given by heating at 100–200° C., if necessary under pressure and with added driers. A product of the above type prepared from Scottish Shale wax by chlorina-

tion, dehydrochlorination, condensation with maleic anhydride, and esterification with methyl alcohol gives a solution in xylene, containing driers, which dries hard after 24 hours to a pale, glassy but soft coating with good adhesion. Stoving gives considerably harder films, particularly after 3 hours at 100° C. Similar useful products are obtained from chlorinated paraffin wax. C. L. G.

698. Anti-Corrosive and Anti-Fouling Paints. Anon. *Chem. Tr. J.*, 16.4.43, **112**, 357.—In a paper delivered to the Institution of Naval Architects on 15th April, G. D. Bengough and V. G. Shepheard reviewed the work of the Marine Corrosive Sub-Committee of the Corrosion Committee of the Iron and Steel Institute and the British Iron and Steel Federation, which has for the last few years been studying the combined problems of corrosion and fouling of ships' bottoms. Methods proposed for the suppression of corrosion and fouling are based on (1) special metals or alloys, (2) electrical systems, and (3) paints and compositions. Of these (3) is the only method in general use and normally consists of one or more anti-corrosion coats followed by one relatively thick anti-fouling coat. The adhesion of the first coat is assisted by (1) pickling, (2) weathering, or (3) weathering and immersion in water (during fitting out), each method being followed by scratch brushing before painting. The anti-corrosion composition may act in one or more of the following ways: impermeability, electrochemical action, and inhibitive action. The paint base, which provides impermeability, may consist of natural or synthetic drying oils or resins, bitumen, wax, chlorinated rubber, and driers. Electrochemical protection is afforded by metallic zinc or aluminium, which is particularly useful for the protection of small areas of steel where paint is stripped or loose. Inhibitive chemicals include oxidizing agents such as red lead or chromates which produce insoluble protective films, the former being less useful for under-water paints, owing to slow drying and tendency to encourage pitting on exposed areas of steel, but more suitable for boot topping and top-side regions. Zinc and barium chromates may be better inhibitors for continuously submerged areas, though they are not in general use, apart from the use of zinc chromate for seaplanes and flying-boats, etc. The toxic ingredients in anti-fouling compositions are usually compounds of copper, mercury, and arsenic, and occasionally an organic poison, these having a selective action on different organisms, particularly the organic poisons. Immersion tests in the sea have been carried out on 35 anti-fouling products, the life of such products varying from 5 to 56 weeks. Further investigation will be made of the optimum consistency or brushability of various types of bottom compositions. Considerable improvement in protective value is obviously necessary for the poorer grades. For most shipping routes the expensive poisons will not be necessary, but the following types of compositions will, in general, be required:—

(1) A general all-purpose paint for the Royal Navy.
(2) A high-duty paint for routes subject to severe animal or weed fouling.
(3) A high-duty composition for the main inlet and discharge trunkings specially liable to mussel fouling.
(4) A non-mercurial composition prepared from home produced chemicals.

In connection with (4), mercury is three times as effective as copper against barnacles and twice as effective against weeds. Many organic poisons are more effective than mercury compounds when added direct to sea-water, but are masked when incorporated in paints. Further work on the selection of suitable media and pigments is therefore necessary. C. L. G.

699. Co-polymer Vinyl Resins. Anon. *Chem. Tr. J.*, 16.4.43, **112**, 359.—Progress in the production and application of vinyl chloride-acetate co-polymers was described by J. D. Benedito in a recent paper before the Canadian section of the Society of Plastics Industry. Four grades of Vinylite resin of the above type are marketed, varying in vinyl chloride content and molecular weight, viz. VYLF, 85–88% (5000); VYHH, 85–88% (10,000); VYNS, 88–90·5% (18,000); VYNW, 95% (25,000). With increase in molecular weight and vinyl chloride content, solubility in organic solvents is reduced and the product becomes tougher and of higher softening point, and when plasticized becomes more elastic. The largest single war-time outlet for the vinyl resins is the extrusion of plasticized compounds for cable insulants and jacketing, where they have

almost completely replaced natural rubber. Compared with rubber, they are more flame resistant, and are, in fact, non-inflammable; they are more resistant to oxidation, ageing, and chemical attack, and have higher abrasion resistance. They have high dielectric strengths and insulation resistance values and can withstand cracking even at − 45° F. Other important applications include proofing of fabrics (service raincoats, ground sheets, tents for winter use) and linings for plating and pickling tanks and for concrete, oil, and storage tanks.

A recently developed modification gives better adhesion without loss of chemical resistance, and holds promise for use in plant against corrosive vapours and for the coating of magnesium and aluminium alloys. The moulding and extrusion of rigid vinyl products are likely to develop after the war for the production of tough abrasive resistant floor-tiles, and of rigid sheets for, *e.g.*, playing-cards, name-plates for machinery, records, radio dials, containers, etc. Their high tensile strength and natural elasticity suggest their use in post-war hosiery. while to-day filter cloths for corrosive slurries and felts, using the staple fibre as a binder, are made on the commercial scale. C. L. G.

700. Charts on Plastics. C. A. Redfarn. *British Plastics*, May 1943, **14**, 738.—A series of charts, with explanatory notes, has been reprinted from the 1943 *British Plastics Year Book* showing the derivation, manufacturing processes, and applications of the following types of plastics: casein, cellulose, phenolic (moulding powders, laminated materials and miscellaneous products), urea, polymethyl-methacrylate, styrene, vinyl, and Nylon. A further large chart gives a comprehensive view of the basis, types, and applications of the principal plastics. C. L. G.

701. Patents on Special Products. L. Liberthson. U.S.P. 2,307,743, 12.1.43. Appl. 7.1.41. An improved petroleum sulphonate product is obtained by intimately contacting in the presence of water a solution of a petroleum sulphonate stock, derived from the acid treatment of a petroleum lubricating-oil distillate, in a solvent for this sulphonate, with an alkali metal chlorite. Afterwards a petroleum sulphate product substantially stable during storage and substantially non-darkening when subjected to high temperatures is recovered.

L. Liberthson. U.S.P. 2,307,744, 12.1.43. Appl. 17.5.41. Preparation of a composition capable of forming substantially stable, non-foaming aqueous emulsions of the oil-in-water type. This consists of an aqueous phase emulsifying agent for the hydrocarbon of the water-soluble soap type and 0·25–1·0% of chromium oleate calculated on the emulsifying base.

C. M. Thacker. U.S.P. 2,309,718, 2.2.43. Appl. 1.12.37. Paraffinic gases are converted into higher-boiling hydrocarbons by contacting them at high temperature in the presence of sulphur with an oxidation catalyst. Resultant organic sulphur compounds are separated from the remaining reaction products, and are then contacted at high temperatures with a catalyst capable of splitting off hydrogen sulphide from the organic sulphur compounds.

C. Weizmann. E.P. 552,551, 14.4.43. Appl. 12.7.40. Entirely aromatic liquid products are produced from light olefins, such as propylene, butylene, or the impure olefins resulting from the cracking of mineral oils by passing the original material over the oxides of zirconium, hafnium, thorium, cerium, or the metals of the rare earths at a temperature between 600° and 800° C. and at approximately atmospheric pressure.

J. W. Orelup. E.P. 552,882, 29.4.43. Appl. 21.7.41. Petroleum products, more particularly relatively colourless products used as fuels, are effectively coloured by means of a composition consisting of diphenyl and an oil-soluble dye.

H. Baehr and W. Deiters. U.S.P. 2,312,064, 23.2.43. Appl. 22.4.39. Dihalogenated saturated hydrocarbons are produced by bringing an olefinic hydrocarbon into contact with an equimolecular amount of a halogen of the group consisting of chlorine and bromine. At least one of the starting materials is admixed with a gaseous hydrogen chloride and hydrogen bromide. The total amount of hydrogen halide present in the reaction mixture is at least equimolecular to that of the olefinic hydrocarbon present.

H. Pines and V. N. Ipatieff. U.S.P. 2,315,078, 30.3.43. Appl. 20.2.42. Substantial yields of alkyl *cyclo*hexane hydrocarbons are obtained from *cyclo*hexane hydrocarbons by reacting an alkyl *cyclo*pentane hydrocarbon with an olefinic hydrocarbon in the presence of a catalyst consisting essentially of hydrogen fluoride as its active ingredient. H. B. M.

Detonation and Engines.

702. Effect of Altitude on Knock Rating in C.F.R. Engines. D. B. Brooks. *Bur. Stand. J. Res.* (Wash.), 1942, **28** (6), 713–734.—Since the standardization of the A.S.T.M. Motor Method in 1933 and of the C.F.R. research method in 1939, knock ratings made by laboratories at higher altitudes have frequently failed to agree with ratings made by other laboratories at sea level.

The National Bureau of Standards was asked in 1941 to assist in determining appropriate conditions for knock rating by both these methods at altitudes by co-operative tests in altitude chambers.

A standard C.F.R. unit with ice-tower humidity control was installed. In the preliminary tests determinations were made for each modification of the induction system (venturi size, throttle plate) at a series of altitudes up to 8000 ft. of (*a*) compression ratio for constant absolute compression pressure, (*b*) compression ratio for standard knock intensity at two specified levels of octane number, (*c*) compression ratio at which the rating of a sensitive fuel was the same as that found for it at sea level. Additional tests were made using three additional cylinder assemblies to make certain that results were not biased by engine idiosyncrasies.

Results showed that :—

(1) Ratings made at constant knock intensity were independent of air pressure.

(2) Constant knock intensity was not obtained at constant absolute compression pressure.

(3) Compression ratio for constant knock intensity was a curvilinear function of air pressure.

(4) The micrometer setting for constant knock intensity was a linear function of air pressure.

(5) No advantage resulted from the use of more than three sizes of venturi for the Motor Method or one size for the Research Method.

Altitude curves were generally determined from sea level to 22 inches mercury, but were extended in one case to an equivalent altitude of 20,000 feet.

From the results obtained equations were developed to relate cylinder clearance volume for standard knock intensity to air pressure and to octane number for both methods of knock rating.

Equations were also developed to relate octane-number requirement to air pressure, and these were shown to agree with road test data. D. L. S.

703. Low Temperature Performance of Motor Fuels and Lubricants. F. H. Garner. *Min. and Pet. Tech. Mag.* (University of Birmingham), 1943, 8.—Professor Garner deals with the properties controlling performance of motor fuels at low temperatures under : (1) difficulty of starting, (2) poor warming-up and acceleration, and (3) dilution of the lubricating oil. Lubricating oils are then briefly studied from the viewpoints of ease of starting and pumping and of sludging and cylinder wear. Five selected references to the literature are appended. A. H. N.

Coal and Shale.

704.* Economics of Peat Fuel Utilization. G. Howell. *Petroleum*, October 1942, 5 (10), 164.—A plea is made for the utilization in this country of peat as fuel for steam raising and as a raw material for the production of coke, gas, and other derivatives. The technical aspects of the problem are examined, and the composition, distribution, and origin of peat are discussed.

Examples of the use of peat for steam raising are quoted from Germany and Sweden, and it is considered that with suitable furnaces the thermal efficiency of peat

can compare favourably with that of steam coal. Peat, moreover, offers three possible advantages not obtainable with coal: (*a*) a low ash content rarely exceeding 3%, (*b*) negligible sulphur content, (*c*) an ash so light that clinker is never produced. Whilst it is recognized that a variety of factors must be satisfied to obtain efficient utilization of peat, the conventional arguments against its use are considered to be based on scanty data, and it is claimed that the important difficulty of excessive moisture content is met by processes such as the "Peco," which dry peat down to 10% moisture.

The Ziegler process for the manufacture of peat coke as used in Russia, various Italian installations, German use of peat coke in metallurgy, and the possibility of large-scale "destructive" processes for peat in Canada are reviewed, and commercial yields of coke, gas, oil, wax, chemical derivatives, etc., from various processes quoted.

J. C.

705. **Gas Industry Research.** Anon. *Chem. Tr. J.*, 1.1.43, **112**, 6.—The research problems being investigated by the Gas Research Board include the hydrogenation and complete gasification of coal under pressure (jointly with Leeds University), for the production of large quantities of power gas of normal quality from a wide range of coals and with maximum flexibility in the amount of coke made. The process appears promising on the laboratory scale, and will be studied on a semi-industrial scale. The catalytic synthesis of methane is being studied and progress made in the study of the effect of operating conditions in the catalytic treatment of water gas and synthesis gas. Investigations are being made of the catalytic removal of organic sulphur compounds from these gases and from town gas. Work on the liquefaction of methane and other gases is likely to be of value for the separation of methane from coal gas, for use as fuel gas, or as an enricher, and of impurities and various constituents of coal gas of special application in the chemical industry. An investigation is also being made into the extent of increase of yield of benzole and toluene from coal by the cracking of tar injected into the charge during carbonization in a continuous vertical retort.

C. L. G.

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Explicacion del Nuevo Mapa Geologico de España. Vol. 2. **El Sistema Siluriano.** Part 1. **Text.** Part 2. **Species, Bibliography, and Classification Table.** Instituto Geologico y Minero de España. Pp. 592 and 256. Gráficas Reunidas, S.A., Hermosilla, 108, Madrid. By Primitivo Hernandez Sampelayo.

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Geology and Development.

706. Deposits of Natural Gas in Poland. Z. S. Wyszynski. *Min. and Pet. Tech. Mag.* (University of Birmingham), 1943, 41.—The geology of the Polish Carpathian and preCarpathian Oil and Gas zones is outlined. The reserves of natural gas in Poland are then discussed in a little detail. The uses to which natural gas was put are enumerated. (1) As fuel (boilers, house heating, etc.). (2) As Fuel for internal-combustion gas engines (heavy rail and road vehicles, stationary motors). (3) For lighting purposes. (4) For extracting of natural-gasoline ("wet" gas only). (5) For enrichment of coal-gas (gas works at Luck, Rowne, Torun, Bydgoszcz, Gdynia, Czestochowa, and other towns, sometimes hundreds of miles away, were supplied with liquid natural gas in special steel bottles under pressure). (6) In metallurgical processes (carburation of steel). (7) As raw material for chemical industries (fabrication of NH_3 from CH_4). A. H. N.

707.* Oil Reserves in the United States. Anon. *World Petrol.*, April 1943, **14** (4), 64.—The annual report of the A.P.I. committee on petroleum reserves estimates the U.S. reserves at the end of 1942 to be 20,082,793,000 brl., 493,497,000 brl. more than at the end of 1941. The 1942 production was 1,385,479,000 brl. Therefore the increase in visible reserves in 1942 was 1,878,976,000 brl., 260,051,000 brl. of which was attributed

to oil found in entirely new pools, and the rest to upward revision of the amount of oil known to be contained in old fields.

The estimates of proved reserves do not reflect the availability or the rate at which the reserves can be produced, with or without physical waste.

Tables give by States the proved reserves at the beginning and end of 1942, the proved new reserves and production in 1942, and a summary of the A.P.I. committee's annual reports covering the period 1937–1942. G. D. H.

708.* Oil Supply Problem Demands Early Solution. S. J. Pirson. *Oil Wkly*, 5.4.43, **109** (5), 51.—The maintenance of known unproduced oil supplies adequate for all long- and short-term eventualities and properly situated geographically is a problem aggravated, but not created by the U.S. participation in the war.

In recent years about 10% of all wells drilled in U.S. have been wildcats, and about one in ten of the latter has been successful. Until 1941 the discovery rate of oil remained above the rate of consumption; in 1942 the deficiency of discoveries compared with production may be 585 to 1068 million barrels, although exploratory drilling in 1942 was at a record high. The fields discovered in 1942 were small, and indicate the efficiency of modern discovery methods.

There have been cycles of efficiency in the discovery of oil. The successive peaks can be associated with the use of the non-technical wildcatter, surface geology, subsurface geology, and geophysics. Now hopes are centred on the geological theories of stratigraphic accumulation, and on new prospecting techniques (deep electrical resistivity and geochemistry). In stratigraphic prospecting new tools as well as refined older techniques are brought into use.

Reserve estimates are based on the use of the best production practices, and withdrawals at rates above the optimum may reduce the visible reserves by 15–20%. Hence the reserve problem also involves the question of an adequate rate of productivity.

Synthetic oil might be made to improve the oil situation, but it is expensive, requires expensive plant and a large number of workmen, and the situation is similar with regard to oil from shales. Secondary oil-recovery methods require favourable sand conditions, and shallow sands (for water-flooding to be economical), and even then are unlikely to give a suitably high rate of production. Increased wildcatting may solve the problem if undiscovered reserves remain and they are largely in stratigraphic traps. Stratigraphic traps seem likely to hold the bulk of the undiscovered oil. They may be lenses formed in a variety of ways, truncations, pinch-outs, etc.

The geological search for stratigraphic traps would entail the location of surface and subsurface uplifts, the construction of detailed palæogeographical maps, and the construction of isopachous maps, supplemented by core-drilling for geological data, the borings being surveyed by appropriate methods.

At present three-quarters of the oil discoveries are made by small independent operators and companies. Wildcatting will only be encouraged by hopes of substantial financial returns. Increases in the price of crude oil, and in the depletion allowance, and the allowance of large production for discovery wells with exemption from taxes on the profit they give, are possible stimulants for wildcatting.

Wildcatting must be controlled to avoid wastage, and at the same time the controlling authorities could provide and co-ordinate vital information. G. D. H.

709.* Increased Costs and Low Prices Destroying Discovery Machinery. F. Buttram. *Oil Wkly*, 5.4.43, **109** (5), 73.—Many have tried to convince war-emergency authorities in charge of price control that the oil producer is limited in his effort by the margin between operating costs and the cash realized from the sale of his crude oil. Crude-oil prices were "frozen" about eighteen months ago, and since then Congress committees have studied the matter, and the Army and Navy authorities have expressed concern over the supply position. Increased wildcatting has been called for.

The deficiency of discovery, abandonment of stripper wells, and idle secondary-recovery reserves are all consequences of low oil prices.

Two-thirds of the 1942 discoveries were made by independent operators, and for several years independent operators have found over 70% of the new fields.

Wildcatters are going out of business, and so the various parts of the machinery of discovery effort are becoming scattered. Hence it is not surprising that a quarter of

1943 has gone without any sign of the revival and increase in wildcatting which have been called for.

Scarcity of materials, inability to compete in the labour market under present conditions, and threats of an attack on the depletion allowance and on the intangible-expense option are further problems of the oil industry. G. D. H.

710. Oil Men Vote Increased Crude Prices as Most Important of Possible Stimulants to Wildcat Drilling. L. J. Logan. *Oil Wkly*, 5.4.43, **109** (5), 42.—A ballot paper on the possible stimulants for increasing wildcatting was sent to companies and operators that drilled fifteen or more wells in 1942, and to outstanding wildcatters, drilling contractors, and others. The ranking of possible stimulants was sought, but in determining the aggregate result of the ballot unplaced possible stimulants were ignored. The proposition to stimulate wildcatting by increased crude prices was placed well ahead of all other propositions. Second in rank was the "Proclamation of a sympathetic and reasonably long-range government policy with regard to wildcatting and the development of new fields, which will dispel misgiving over controls and discretionary powers of administrative agencies." The making of materials and equipment more readily available nearly tied for second place. The fourth place was held by the proposition of more liberal daily allowables for new producing areas, towards the end of hastening pay-out of investments, and a close fifth was the alleviation of existing or prospective manpower shortage. In the sixth place was the giving of "greater assurance of pipe-lines or other market outlets for any production established."

Many balloters called for the retention of depletion allowance and deduction of intangible drilling costs in determining income tax, and for the decentralization and simplification of P.A.W., these points occupying ninth and tenth places respectively without having been printed on the original ballot paper. Motor transport was considered as only a minor obstacle to wildcatting.

"Government subsidies to aid in drilling of promising prospects" and "The setting up of a government owned and controlled operating company, to participate in active search for new fields" were two propositions scratched out or ignored by many voters as unworthy of consideration as possible stimulants. G. D. H.

711.* Discovery Thinking. A. I. Levorsen. *Oil Wkly*, 12.4.43, **109** (6), 11; 19.4.43, **109** (7), 14; 26.4.43, **109** (8), 12. See abstract No. 620.—The article in the *Oil Weekly* gives greater detail on some points, and has more diagrams than that in the *Oil and Gas Journal* (8.4.43, **41** (48), 38). G. D. H.

712.* March Drilling Results in Completions Gain. Anon. *Oil Wkly*, 12.4.43, **109** (6), 42.—1476 wells were completed in U.S.A. in March 1943, compared with 1280 in February. The main gains were in Illinois, Oklahoma, and Texas, which had rises of 40, 31, and 42 respectively. Supply difficulties and transport questions are undoubtedly holding back drilling.

A table gives details by States and districts of the completions in March 1943, with comparative totals for February 1943, and March 1942, as well as the cumulative 1943 completions. G. D. H.

713.* Declining Output of Illinois and Oklahoma Becomes Serious. A. R. McTee, *Oil Wkly*, 19.4.43, **109** (7), 9.—The present daily output of Oklahoma and Illinois is 100,000 brl. below the level of a year ago, and is still declining. This fall is complicating the problem of moving available production and products to the East Coast, and throwing a heavy burden on other oil States. Unsatisfactory exploratory results in 1942 in these two States indicates a probable continuation of the downward production trend.

Compared with the first quarter of 1942 the Illinois production has fallen by 114,000 brl./day, and that of Oklahoma by 57,000 brl./day. Kansas, the third largest producing State of P.A.W. District 2, has been able to assist in offsetting the decline by increasing its output by 60,000 brl./day, but it is now probably producing practically at its maximum rate. Additional supplies will therefore have to come from Texas, which is not well located geographically for meeting the deficit. At the same time Texas will have to supply 300,000 brl./day to the 24-inch pipe line, and 200,000 brl./day to the 20-inch product line.

At the end of 1942 the Illinois crude reserves were estimated at 306,778,000 brl., a fall of 26,939,000 brl. during the year. The Oklahoma reserve at the end of 1942 were 968,927,000 brl., 66,893,000 brl. less than a year earlier. The Kansas reserve changed but little in 1942, and amounted to 686,975,000 brl. at the end of the year.

A committee has suggested to P.A.W. that the ceiling price of crude oil should be advanced 25 cents, and that secondary recovery methods should be applied as a means of increasing production.

Tables show the trend of District 2 crude production and stocks in 1941, 1942, and 1943, and the trend of reserves and discovery rates in 1938, 1939, 1940, 1941, and 1942. G. D. H.

714.* Wildcat Activity Declining Instead of Increasing. L. J. Logan. *Oil Wkly*, 19.4.43, **109** (7), 11.—Instead of the sharp increase in wildcatting in U.S. which the Government has called for, there has been a decline from the rates which have held in the past few years. The March rate was only 2800 wildcats/year instead of 4500/year as required. If the necessary number is to be reached, an average of 420 wildcats/month must be drilled during the remaining nine months of 1943. Up to the end of the first quarter of 1943, 674 wildcats were completed exclusive of semi-wildcats, compared with 716 in the corresponding period of 1942. Only 15·1% of the 1943 wildcats were productive, whereas the corresponding figure for 1942 was 18·7%. Many fewer new pays have been found than in 1942, although new oil and distillate fields were at about the same level. In order to replace current production by new reserves, 125,000,000 brl. of oil must be discovered each month, and this figure may have been attained in March, but some would probably place the figure at 50,000,000 brl. About half the March discoveries were in District 2, where they are most needed, and much of the remainder was in District 3. California has had two unimportant extensions of established fields.

Probably the most important March discovery is the Hall's Bayou field of the Texas Upper Gulf Coast, which may produce 20,000,000 brl. The new field at Shuteston, South Louisiana, is regarded as fairly important, and several other Texas Gulf Coast and South-west Texas discoveries may give up to 10,000,000 brl. each. The Hobson field of the Lower Texas Gulf Coast has established good pays in a deeper sand section (Claiborne and Wilcox), opening a new exploration trend.

Tables summarize by States the results of wildcat completions in March and in the first quarter of 1943; they list the March discoveries with details; and show the trend of wildcat completions. G. D. H.

715.* Hungary Furnishing Most Important Developments in Continental Europe. Anon. *Oil Wkly*, 19.4.43, **109** (7), 57.—Plans are being carried out for constructing natural gas pipe-lines from northern Transylvania to Cluj and other Hungarian industrial towns. A lubricating-oil refinery is to be built in Hungary to process domestic crude.

During 1942 Hungary is estimated to have produced 3,800,000 brl. of crude, compared with 2,600,000 brl. in 1941. The 1942 production of petroleum substitutes is estimated at 200,000 brl.—about twice the 1941 figure. The Hungarian oil output has substantially exceeded domestic needs in the last two years, making about 2,000,000 brl. available to Germany in 1942 alone. The Axis petroleum and substitute output was probably 112,000,000 brl. in 1942.

The main Hungarian production is in the Budafapuszta region, around what was formerly known as the Lispe field.

In the Lovaszi area oil was found in 1941 at depths of 4950–5400 ft., the early wells giving about 800 brl./day of 39-gravity oil. Lispe is reported to have 40 wells on production, and in 1940 was giving about 5000 brl./day from 3950–4950 ft. Across the border the Selenico and Peklenico fields of Yugo-Slavia yield about 10 brl./day each. G. D. H.

716.* Wildcatter's Spirit Must Not Be Crushed. D. J. Jones. *Oil Wkly*, 26.4.43, **109** (8), 14.—It is generally believed that practically all the large structural features of U.S. are known, and so the smaller features and stratigraphic traps must be the source of future oil supplies, with the latter providing most of the new reserves. In order to discover stratigraphic traps an increased number of exploratory wells will have

to be drilled under the supervision of the industry's best-trained technical experts. However, a fair number of these wells should be drilled by the ordinary independent wildcatter, who will play a very important part in discovering adequate reserves, and even when he fails he will add to the industry's stratigraphic knowledge.

The encouragement of wildcatting by bonuses and subsidies seems to require complicated administrative machinery, and may be unfair and impracticable in many cases. The present task of discovering adequate reserves is too big even for the major companies with all their resources of money and men.

Unless some drastic stimulant in the form of an advance in crude oil prices is forthcoming the wildcatter and the individual operator are likely to disappear. Increased cost of labour and materials and man-power shortage are making it very difficult for the smaller operators to carry on. In many cases they are unable, and perhaps unwilling, to embark on secondary recovery projects under present crude price conditions. A rise in price of 50 cents/brl. is necessary. This will stimulate many to greater efforts, and lead to some tests which will open pools in areas where the best minds of the industry would not recommend drilling. G. D. H.

717.* Influence of Bacterial Activity on Source Sediments. C. E. Zobell. *Oil Wkly*, 26.4.43, **109** (8), 15.—Significant numbers of living bacteria are found in recent marine sediments even at depths of over 3 ml. and at the base of 17-ft. cores. Stratigraphic changes in the organic and sulphate content of cores show that the bacteria are active *in situ*, and their activity may continue although the temperature, pressure, and salinity may vary widely. Many of the bacterial species found in sediments are physiologically versatile, and most are facultative ærobes. The pH of sediments is influenced by bacterially produced acids or bases, and thus chemical reactions and the precipitation or solution of calcium carbonate may be altered. Bacteria tend to create reducing conditions in marine sediments, and such conditions favour the formation of petroleum hydrocarbons. Methane-producing bacteria are widely distributed in the sea. Carbon dioxide, carbon monoxide, hydrogen, and hydrogen sulphide are formed by bacteria, sulphates are reduced, sulphur precipitated, and the aggregation of particles and the lithification of sediments are influenced by them. Bacteria may not produce petroleum directly, but they certainly convert organic matter into substances which are more petroleum-like. They can convert methane into bacterial protoplasm, and may be able to polymerize it to form higher hydrocarbons. Many bacteria liberate fatty acids from fats and oils, and the removal of two oxygen atoms from the fatty acids would result in the formation of fairly long-chain hydrocarbons. Some bacteria destroy petroleum hydrocarbons, a process which may be responsible for the failure of workers to find petroleum hydrocarbons in recent sediments or in experimental material with mixed cultures. This destruction might occur during transport and storage of samples prior to analysis, or might occur *in situ* in all except certain environments (hydrogen sulphide, certain heavy metals and other substances inhibit the oxidation) which are unfavourable to the activity of the hydrocarbon-oxidising bacteria.

Changes produced by hydrocarbon-oxidizing bacteria in surface soils over subterranean oil deposits from which volatile hydrocarbons are escaping may serve as useful indicators in searching for oil. G. D. H.

718.* Frequency of Dry Holes Rises Sharply in Kansas Completions. J. A. Kornfeld, *Oil Wkly*, 26.4.43, **109** (8), 38.—In 1942 in Kansas dry holes were 41·7% of the total completions, a rise of 15·1% above the 1941 figure. In 1942 90% of the wildcats were failures, and in 1941 85·4%. Few, if any, of the 1942 discovery wells were more than 10 ml. from the nearest developed producing area. The increase in the proportion of dry holes in the state in 1942 is partly due to wildcats being 23·6% of the total completions instead of 12·6% as in 1941. 26·7% of the non-wildcat wells were dry in 1942, compared with 18·1% in 1941.

Tables give the numbers of oil, gas, and dry wells completed each year from 1937, and compare the results of wildcat and pool drilling in Kansas in 1941 and 1942. G. D. H.

719. Colombian Activity May be Helped by Proposed Law. Anon. *Oil Gas J.*, 29.4.43, **41** (51), 38.—The proposed new Colombian oil law minimizes title litigation,

does not require drilling before relinquishing an explored concession, and increases taxes only on new contracts. Production taxes will range 3 to 13%, depending on distance from the petroleum-gathering system, and surface taxes will be 20 centavos in the first two years in the less accessible areas and 30 centavos in others, and 3 pesos in the eleventh year in the former and in the tenth year in the latter. The usual concession area will be reduced from a maximum of 50,000 hectares to 25,000 hectares, and from a minimum of 5000 to 3000 hectares.

The war has virtually stopped oil operations in Colombia by depressing markets and preventing the importation of equipment. The 1942 production was 10,600,000 brl., compared with 24,650,000 brl. in 1941. Lack of equipment has prevented complete definition of the new Casabe area, where the discovery well was completed at 8280 ft. in October 1941. Nine wells have been drilled which average 3700 ft. The field produces from exceptionally thick sands, and lies on the west bank of the Magdalena, north-west of Infantas and La Cira.

On the Barco concession producing wells have been completed on or near highs at opposite ends of a 15-ml.-long structure. Two wells have been completed on the Socuavo dome in the north, and three on the Tres Bocas dome in the south, one well in each case proving commercial. Socuavo No. 2 flowed 200 brl./day of 35° A.P.I. oil from 5575 ft., and Tres Bocas 2-A 1000 brl./day.

Cimitarra 2 has encountered oil-shows. G. D. H.

720. Canadian Government Takes Over Operation of Athabaska Oil Sand. Anon. *Oil Gas J.*, 29.4.43, **41** (51), 43.—The pilot plant of Abasands Oils, Ltd., which was destroyed by fire in 1941 and rebuilt in 1942, has been taken over by the Government, $500,000 having been appropriated for the improvement of plant and processes.

The Athabaska tar-sands are estimated to contain 250,000,000,000 brl. of oil, and outcrop or lie under 8–200 ft. of overburden. Excavation is by light blasting and power shovelling, the oil then being separated by flotation with recoveries estimated at 28–30 brl./40 ton of sand. The oil was used chiefly as a diesel fuel on northern river-craft.

The operating problems include winter difficulties, economic mining methods, separation of bitumen from the sands, and treatment of the bitumen to give diesel fuel, gasoline, lubricants, etc., removal of 7–8% of sulphur, location of uniform, rich sands with little overburden, and the disposal of the sands, overburden without polluting streams. The raw sands have been successfully used for surfacing roads when mixed with dry sand and crushed stone. Certain peculiar qualities of the separated crude indicate a possibility of working out a synthetic rubber process in conjunction with a refining plant. G. D. H.

721. Oil Zones of the United States: Lower Mississippian. Anon. *Oil Gas J.*, 29.4.43, **41** (51), 72C.—In the area between the Appalachians and the Cincinatti Arch sandstones and shales form the bulk of the Lower Mississippian deposits. In the eastern part, the Berea is the only widespread sand, and it occurs in West Virginia, Kentucky, Ohio, and Michigan. The Weir, Squaw, Big Injun, Beckett, and Keener are oil-sands of local importance. Shales form the base of the Mississippian in the Illinois basin, and later there were thick limestones, some of which were separated by unconformities. Some oil has been found in the top of the St. Louis limestone, but the McClosky is the main pay, being an oolitic member of the basal Ste. Genevieve. Some oil is obtained from two upper members of the Ste. Genevieve. West of the Ozarks the main pay is the top of the "Boone" (Mississippi lime or chat), and this is of importance in eastern Kansas. Recently Mississippi lime production has been found on the west flank of the Bend Arch. The Madison limestone (Mississippian) is the oldest known pay of the Rocky Mountain area, providing the main oil at Kevin-Sunburst, and shows on the Baker-Glendive anticline.

There are possibilities of Lower Mississippian production in the Williston basin, in the eastern part of the West Texas basin, on the flanks of the Nemaha Granite Ridge, and in the Illinois–Indiana basin.

There are unconformities within and above each of the four extensive limestone formations between the pre-Cambrian and Upper Mississippian, and each has developed porosity and frequently given oil accumulation. The sediments of the basins between the various broad uplifts which developed in this period cannot be correlated over wide

areas, but they have very similar characteristics. More intense movements occurred after the Lower Mississippian, and conditions changed rapidly, causing the subsequent geological history to be different in the different producing sections of the country.

A map shows the Lower Mississippian outcrops, the structural features, the Lower Mississippian producing areas, and those which are favourable and unfavourable for producing from this system. G. D. H.

722.* **Locating Cased-Off Production by Radioactivity Logging.** W. A. Sawdon. *Petrol. Eng.*, May 1943, **14** (8), 43.—Gamma-rays originate in the formations, and, passing through the casing and cement, if present, indicate the character of the formation. The neutron curve measures the effect of bombarding the formation by neutrons from a strong source. In general, shales give the highest gamma radiation, and sands and shales less. The hydrogen in a formation is the chief cause of variation in the intensity of the neutron curve. The connate and combined water of a shale, due to the hydrogen, leads to a low intensity of the neutron curve. An increase in porosity of a formation with oil or water in the pores gives low neutron curve intensities, but the curves do not distinguish between oil and water, since both contain hydrogen.

The gamma-ray and neutron curves together may permit the location of porous horizons in a limestone between shales, and are of assistance in selecting points at which to perforate for cased-off production. Both types of curves may be used for geological correlation in a field. G. D. H.

723.* **Inspection and Analysis of Formation Samples.** L. C. Uren. *Petrol. Engr*, May 1943, **14** (8), 62.—Before determining the porosity and permeability of a part of the formation sample, any liquids therein must be removed. This is best done in a Soxhlet apparatus, preferably by first extracting with benzene to remove petroleum and petroleum residues, then extracting with acetone to remove water, and finally extracting with pentane to displace acetone. The extracted specimen is then dried below 210° F. Specimens for permeability measurements are cut to a form and size which depend on the core-holder in the permeameter used and on the direction (perpendicular or parallel to the bedding) in which the measurement is to be made. Air is generally the most convenient fluid with which to make the measurement, but at times oil is preferred. The apparatus must provide means for controlling the pressure upstream and measuring the value of the pressures at the up- and down-stream faces of the core, for filtering the liquid used, for measuring the specimen's dimensions, controlling the temperature, and measuring the rate of fluid flow. It is usual to measure the permeability at several pressure gradients, and in the case of gases the preferred value is obtained by plotting the values against the reciprocal of the mean pressure and extrapolating to zero reciprocal mean pressure.

The gross fluid content of the sample is purely the loss in weight on extraction. The water content is determined by submergence in a solvent, such as xylene, and heating to drive off the water and condensing it in a suitable receiver. The oil content is determined by difference. Alternatively both oil and water may be distilled off and collected, certain corrections being made, and the result being checked by weighing the specimen before and after distillation.

The amount of oil in a core is but a poor basis for finding the oil gravity, and it is best to measure gravity on oil produced directly from the formation. Fairly satisfactory results may be obtained by pyknometer measurements on oil distilled from the core, provided that corrections are made to allow for changes in the oil during retorting.

An extensive bibliography is appended. G. D. H.

724. **Devonian Production Gaining in Importance in Western Illinois Basin.** Anon. *Oil Gas J.*, 6.5.43, **41** (52), 150.—The first Devonian lime oil of the Illinois basin was found at Siosi in south-west Indiana in 1926, and the first important Devonian production in Illinois was found at Centralia in 1940. Since then the Devonian has been found to be productive in more than a dozen fields in Illinois. In Illinois the term "Devonian" is applied to a body of limestone several hundred feet thick immediately below the Kinderhook-New Albany shale, and of Devonian and Silurian age. Both systems are present over much of the basin.

Commercial Devonian production was obtained in the Colmar–Plymouth field in

1914 at a depth of 420 ft. The oil is in the Hoing sand on an anticlinal-type structure, and the ultimate recovery may be 1702 brl./acre. The Martinsville field was opened in 1937 with production from several Devonian sands and from the Trenton. Two Devonian wells were brought in at Decatur. Sorento has three Devonian wells at depths of 1830 ft. The Sandoval Devonian, opened in 1938, has proved more prolific than many other Devonian fields. The upper horizons were practically drilled up when Devonian production was established at Centralia, where the ultimate Devonian recovery is estimated at 3125 brl./acre for the whole field. The Devonian pay at Salem is an extremely porous limestone at about 2860 ft., and it may yield 6000 brl./acre. The Louden Devonian pay is about 15 ft. thick and 3000 ft. deep, with an estimated ultimate recovery of 4500 brl./acre. Bartelso, Irvington, and Tonti are other fields with Devonian production.

In most of the Devonian producing fields of Illinois the pay has been found to be in close contact with a water-table of water-drive proportions. Recently Devonian production has been found at Boulder, South Bartelso, and Patoka, but only a few wells have been drilled in these cases. A new area in the northern part of the Illinois basin has been opened to Devonian exploration by a strike in northern Christian county, 50 ml. north of the prolific Devonian area surrounding Louden and Salem.

A map shows the sites of the Devonian pools in the western part of the Illinois basin.

G. D. H.

725.* Drilling Increases in April; Wells Completed at Rate of 18,000 Yearly. Anon. *Oil Wkly*, 10.5.43, **109** (10), 63.—The weekly well completion rate in U.S.A. in April was 345, 18% higher than the March rate, but 16% below the April 1942 rate. The weekly rates in January and February 1943 were respectively 346 and 320. During April there were notable increases in field work in Pennsylvania, West Virginia, Kansas, North Louisiana, Michigan, New Mexico, Eastern Texas, and West Central Texas, where there were more completions in four weeks than in the preceding five weeks. There were also increases in the weekly average in Arkansas, Illinois, Ohio, Oklahoma, North Texas, and West Texas.

Details of the April completions are tabulated by States and districts, with total completions for March 1943 and for April 1942, together with cumulative completions for the first four months of 1943, and details of the rigs on 1st May, 1943.

G. D. H.

726.* Canadian Company Drilling Gaspe Peninsula Deep Test. Anon. *Oil Wkly*, 10.5.43, **109** (10), 64.—An 8000-ft. test has been begun on the Galt Brook dome on the Gaspe Peninsula, south of the St. Lawrence. In excavations for the derrick foundations live petroleum was encountered. The hard surface limestone has been penetrated for 26 ft.

G. D. H.

727. New Oil Supplies and Greater Production Efficiency Considered by A.I.M.E. H. F. Simons. *Oil Gas J.*, 13.5.43, **42** (1), 30.—One of the best places in which to seek new oil supplies is in deeper horizons underlying present producing fields, for structural traps often have oil in a number of superimposed traps. Denison considers that no structural trap is condemned until the basement rock is reached. Consequently, in northern Oklahoma and most of Kansas less than 1000 ft. of additional sediments remained to be tested; in the Seminole area only four tests have gone below the Wilcox and there are about 4000 ft. of sediments below the Wilcox; in the East Texas basin 4000–10,000 ft. of sediments require prospecting below the Woodbine, and already production has been found in the Paluxy, Glen Rose, and Travis Peak; on the Gulf Coast 7000–10,000 ft. remain to be tested before reaching the limit of present drilling depths. Near the north edge of the Panhandle oil- and gas-fields, some 6000 ft. of sediments lie above the granite; a considerably greater depth remains to be tested on some of the large structures of the West Texas basin. Deeper drilling of this type would require little expansion or change of producing organizations, and there would be little need for further geological or geophysical work for this prospecting.

Knowlton considers that all the U.S. oil areas except the Texas, Gulf Coast, and West Texas are producing at or above the maximum efficient rate. The most economical source of additional oil for the war programme, apart from exploratory drilling,

is secondary recovery. It is probable that 70,000,000,000 brl. of oil remain in present known fields at the end of primary production. 3,000,000,000 brl. or more of secondary recovery oil could be produced by existing techniques at the present or a slightly increased price. G. D. H.

728. Oil Zones of the United States: Upper Mississippian. Anon. *Oil Gas J.*, 20.5.43, **42** (2), 68-C.—Upper Mississippian production is restricted to three areas and is important in only one, the Illinois basin. The Maxton sand yields a little oil in the Allegheny Plateau region. In the Illinois basin the Chester consists of clastics and some limestones, especially in the deeper parts, where sands of the upper members form wedge edges. Producing stratigraphic traps in the lower members are nearer to the edges of the basin. The Degonia, Clore, and Palestine sandstones produce in the Wabash River area; Waltersburg and Tar Springs sandstones in the southern part of the basin; the Hardinsburg and Golconda are minor pays; the Cypress is generally productive in the northern part of the basin; the Paint Creek produces in several fields; the Bethel (Benoist) produces widely as does the Aux Vases. Conditions similar to those of Illinois do not seem to have existed elsewhere in the United States in Chester times.

In Upper Mississippian times local uplifts became more intense, and sheet sands and shales over wide areas were replaced by sands pinching out up-dip and grading into shale down-dip, thus giving depositional stratigraphic traps. These offer best chances where intersected by lines of folding.

As a basin fills the stratigraphic traps approach the middle, but greater submergence may interrupt this trend.

A map shows the Upper Mississippian producing areas. G. D. H.

729. Shell Opens Potential Oil Field in Colombia. J. P. O'Donnell. *Oil Gas J.*, 27.5.43, **42** (3), 32.—1 El Dificil in the Magdalena Department of Colombia has flowed 130 brl./day of 46° A.P.I. crude with 1,300,000 cu. ft. of gas through a $\frac{1}{4}$-in. choke. The well has a total depth of 5930 ft. and encountered a gas cap above the 600 ft. of porous limestone from which it is producing. The tubing pressure is 2375 lb./in.^{2} The well is said to be on major structure and may herald a new field. It is 60 ml. from tidewater, and 100 ml. due south of the port of Santa Marta. The construction of a pipe-line through the generally flat country should be easier and less expensive than the other Colombian pipe-lines. 1 El Dificil is about 30 ml. north-west of 1 El Doce, a dry hole completed at 10,046 ft., 20 ml. to the south-east of El Dificil 1 Brillante is being drilled.

Shell discovered the Casabe field which has nine wells but no outlet. This is a little north-east of the De Mares concession. Two promising new producing areas have been found on the Barco concession, but the prospects need confirmation.

Lack of shipping has virtually eliminated Colombia's oil exports and equipment imports. The first quarter's production of 1943 was 1,034,500 brl. compared with 5,845,000 brl. for the same period of 1942. The production in the last quarter of 1942 was 570,000 brl. G. D. H.

730. More Sedimentary Petrography Needed for Exploration and Development Programmes. W. V. Howard, *Oil Gas J.*, 27.5.43, **42** (3), 38.—Most of the sedimentary petrography now being used falls into three categories: (*a*) Rapid examination with a binocular microscope or hand lens to detect the appearance of a key horizon or of a lithological change. (*b*) Breaking up the rock to study grain size and shape. (*c*) Throwing away much of the rock and studying the remainder in great detail.

Core analysis and the indirect methods of study such as electrical logging, gamma-ray logging, etc., do not add much to the knowledge of the rocks involved.

The geologist uses key horizons for correlation, to tell his structural position, where to case and to core, and when he is near his pay. Cores and mechanical logging information tell the engineer much about the sand productivity, and later will give him data of value in secondary recovery projects.

Most companies separate the exploration and production departments, often losing thereby much information which both could use. There are geological reasons for pressure, interference, water movement, and other irregularities. The reason is not always faulting; it may be changes in lithology. Especially near shore, changes are

likely, and washouts may cut off beds. Detailed studies of the reservoir lithology are frequently very valuable, and in this way the geologist can often solve problems with benefit to the production department. The geologist's attack should be direct, and should not result in a lengthy report with much irrelevant detail, which may be of great scientific interest, but of little practical value. G. D. H.

731. April Completions Continue Increase Started in March. Anon. *Oil Gas J.*, 27.5.43, **42** (3), 115.—1351 wells were completed in U.S.A. in April, 58 more than in March. 767 were oil-wells, an increase of 61 on the March figure. Illinois completions rose by 21 to 156, Appalachian completions by 52 to 262. The decline in Oklahoma completions continued. The number of wells in the 5000–10,000 ft. class has increased to 206, compared with 179 in March and 144 in February. The rise in this class of wells is seen in the Upper and Lower Gulf Coast fields as well as in South Texas.

1449 wells were completed in April 1942.

A table gives a summary of the April operations by States, with the types of completions, footage, numbers of wells in various depth ranges, and the numbers of wells drilling. G. D. H.

Geophysics.

732.* Geophysical Operations at Peak Levels During 1942. E. A. Eckhardt. *Oil Wkly*, 5.4.43, **109** (5), 49.—In the early part of 1943 geophysical activity was above the average for the preceding year. The 4500 wildcats asked for in 1943 are almost 50% above the number drilled in any year previously, and need a corresponding expansion of geophysical activity. This expansion may not be possible, for those engaged in geophysical work are especially suited for the armed forces. Only 15–20% of geophysical personnel are eligible for occupational deferment, and already about 40% of the personnel have been lost to the forces or to civilian technical services.

During 1942 an average of 226 seismograph parties were operating in U.S.A., 35 more than in 1941. 42% of all reported seismic activity was in Texas, which probably contributed 40% of the 1942 reserve additions. An average of 58·8 gravimeter parties were operating in 1942, compared with 54 in 1941.

Geophysical supplies are a less serious problem than was generally expected, but man-power is the greatest source of uncertainty in planning next year's geophysical operations.

Diagrams show the number of seismograph parties operating since the beginning of 1938, and the distribution by States or areas of the seismograph and gravimeter parties during 1942. G. D. H.

733.* Surface Analysis Can Now Tell Hydrocarbon Source. H. Henderson. *Oil Wkly*, 5.5.43, **109** (5), 82.—Stratigraphic traps are generally believed to be the big hope for additional oil supplies in U.S.A., and surface analysis is unique in prospecting, since it will locate stratigraphic traps. During the past eight years progress and improvements have been made in surface analysis, and it is now possible to differentiate between vegetable waxes and the hydrocarbons diffusing from underlying petroleum. Surface concentrations of hydrocarbons such as oil and gas seeps, and paraffin earth have always been considered as indications of oil at depth. This reliability is shown by the fact that in a single geological province they are credited with the discovery of 75 out of the 219 domes found prior to 1936. These may be considered as macroscopic soil-analysis methods. It seems reasonable to suppose that there are low-degree surface concentrations of hydrocarbons indicative of oil at greater depth or under tighter overlying beds.

In 1924 the Tomball field was outlined by the determination of the salinity of near-surface waters, and in 1929 it was found that relatively high concentrations of methane and ethane in the surface soils indicated petroleum at depth. In 1932 the Russians began to measure the concentration of hydrocarbons in surface soils. They fractionated the hydrocarbons and correlated high concentrations of the lighter fractions, such as methane and ethane, with gas at depth, and high concentrations of the heavier hydrocarbons with oil at depth. Work in U.S.A. since 1935 has led to agreement on the leakage of hydrocarbons from subsurface oil deposits, but there is no agreement on the mechanism. The mechanism may be largely diffusion, associated with effusion and permeation. Shallow fields, other things being equal, may be expected to give

greater surface concentrations of hydrocarbons than deep fields, and the escape of the light hydrocarbons may be one of the chief reasons for the low-gravity oil in shallow fields. Recent unconsolidated formations permit much more rapid diffusion than the older more consolidated beds. The pressure gradient, temperature, and formation permeability will affect the rate of leakage, while the retention of the hydrocarbon-gas molecules at the surface will be a function of the absorption characteristics of the surface formation. Thus the concentration of the hydrocarbons over a reservoir is dependent on a number of factors.

The generation of hydrocarbons from decaying vegetation complicates the use of soil analysis. Methane, ethylene, and waxes and fats may be formed from vegetable matter, and in soil analysis these must be distinguished from hydrocarbons from oil reservoirs. Sampling below the surface vegetable hydrocarbon contaminated zone does not give a satisfactory method, and therefore a physico-chemical method has been used to differentiate between vegetable waxes and hydrocarbons which have diffused from petroleum at depth. Relatively recent alluvium and man-made fills will be low in hydrocarbon concentrations.

The form of the hydrocarbon concentration profile is discussed for several simple cases.

Surface analysis is rapid, inexpensive, and does not use large quantities of critical materials, though there remains some doubt regarding its oil-finding power.

G. D. H.

Drilling.

734.* Drilling Well Inside City Limits Made Noiseless and Safe. W. A. Sawdon. *Petrol. Engr*, March 1943, **14** (6), 47–50.—The paper describes the drilling rig built in the heart of the city of Los Angeles. Because of the location and the restrictions imposed, the surface equipment for this well had to be insulated against noise and fire hazard. The derrick is of standard steel construction, but, after erection, was first enclosed with a wooden framework shown photographically in accompanying illustrations. The inside of the framework was covered with chicken wire to hold a thick covering rock-wool, which was then placed within the frame structure to insulate against sound. Outside of the rock-wool, sheets of transite mineral board were attached to the wooden members to make the structure fire-proof as well as sound-proof. This combined insulation covers the entire derrick structure, including the engine-house. The dog-house with lockers is placed on the ground away from the derrick floor, to provide greater convenience for the men.

The only openings in the derrick structure are a small one at the top above the crown block, and another on the side about derrick-floor level for bringing in pipe, tools, and materials. Electric lights must, of course, be used day and night, but reflectors prevent any upward glow through the small opening above the crown-block. Two fans on the derick floor circulate the air and keep it moving upward through the opening at the top. The side opening is covered with a vertical sliding door insulated like the rest of the building. As there are objections to opening this door at night, 90-ft. stands of drill-pipe are made up during the day and placed on the rack within the derrick for use when needed. A "mouse-hole," in addition to the rat-hole, has been provided to take one 95-ft. stand of pipe. Details of the constructions are described and illustrated.

A. H. N.

735.* Correct Method of Applying Clips to Wire Rope. F. L. Spangler. *Petrol. Engr*, March 1943, **14** (6), 58.—By a diagram and a photograph wrong and right methods of applying clips to ropes are given. Particulars for number of clips, etc., are summarized in following table :—

Rope Diameter, in.	Number of Clips.	Spacing of Clips, in.	Length of Wrench, in.
¼ to ⅝	3	3	12
¾ to ⅞	4	4½	18
1 to 1¼	4	6	24
1½ to 1¾	4	7	24
1½ to larger	5 to 7	10	24

736.* Multiple Batch-Squeeze Cementing. S. P. King. *Petrol. Engr*, March 1943, **14** (6), 74.—Multiple batch-squeeze cementing jobs can be more efficiently supervised by utilizing brief forms that convert the entire job into a series of gauge-tank measurements. This technique has been found especially adaptable in foreign fields where native labour and the lack of modern cementing equipment and trained personnel frequently augment the petroleum engineer's responsibility on the job. Many improvised cementing units consisting of pumps, slurry tanks, and mixing hopper mounted on truck or trailer, if properly handled, can function very efficiently. The usual lack of flexibility in pumping, inability to achieve any adequate mechanical control over mixing speed or slurry weight, plus the not infrequent unavailability of a particular type of cement for a specific purpose, tend to complicate a straightforward cement job. In these circumstances it is to the engineer's advantage to organize his work to provide a maximum allowance for any eventualities requiring his personal supervision.

The author illustrates these remarks by giving the details of a typical job, including the calculations which are necessary and the procedure to be adopted. A. H. N.

737.* Recent Developments in Formation Logging. Part 2. L. C. Uren. *Petrol. Engr*, March 1943, **14** (6), 84.—The normal geothermal gradient is about 1° F. for each 60 ft. of depth, in some localities much greater, but this is appreciably altered in the vicinity of formational intervals in wells where gas is expanding or liquids are flowing from the well into the formation, or vice versa, or where chemical change is occurring—as, for example, in the setting and hardening of cement behind casings. Knowledge of these local variations in the normal temperature gradient is of assistance in locating the positions of water, oil and gas sands, or gas-oil contacts in producing reservoirs, in determining variations in permeability of component members of an oil- and gas-producing zone, locating casing leaks or the source of water entering a well, or locating the top of a column of cement in the annular space behind a string of casing. Temperature surveys have the advantage over some other methods of gathering subsurface information, in that they can be applied to the inside of casing.

Thermometers used in making temperature surveys in wells are of three types. (1) The maximum mercury thermometer, which, on being lowered into a well and withdrawn, indicates the maximum temperature reached. (2) The self-contained continuously-recording type, which is designed to be lowered through the well on a wire line and indicates the temperature at all depths on a record contained within the instrument, the results being available only after the instrument has been withdrawn to the surface. (3) The continuously-recording type, in which only an instrument responsive to thermal change is lowered into the well, while the temperature is simultaneously indicated or recorded on an instrument at the surface. The three types are described in some detail.

The use of temperature logging for detecting the presence of oil or gas sands, or the level of cement behind casings and for correlation of formations is described.

The paper ends with a discussion of inspection drilling mud as a method of logging with a trailer—mounted set of instruments. In the process of drilling, the bit disintegrates the formation in its path, and fluids present in the pore spaces of the rock become a part of the liquid phase of the drilling fluid. Though the amounts of oil, gas, or salt water thus added to the drilling fluid are small, they are sufficient to be clearly apparent in the delicate tests that are applied to the fluid after it reaches the surface. In order to correlate the fluid detected by such tests with a stratum from which it came, it is necessary to take into account the time intervening between the drilling of the material and its delivery at the surface in the drilling fluid. A log of rate of penetration versus depth is also obtained, and differences in the recorded rate of penetration may be used as an index of the lithologic properties of the strata penetrated. The depth to the top and bottom of each sand stratum is thus disclosed, and sands are clearly differentiated from shales. The test equipment employed in this system of logging may be divided into two groups: that used for detection of oil, gas, and salt water in the drilling-fluid returns, and that necessary in registering the depth of the well, the rate of penetration and rate of drilling fluid circulation. The latter must be known to correlate surface observations with the depths to which they relate. The instruments used are electrically operated, and power for operating them is obtained either from the source that drives the drilling rig, or from a 1½-kw. gasoline-engine-

driven generator carried as a part of the equipment of the trailer laboratory. The measurements taken and the methods used are briefly described. A. H. N.

738.* **Special Equipment Controls Shallow Depth Blowouts.** Anon. *Oil Wkly.* 26.4.43, **109** (8), 30.—Certain fields in west Texas present a problem of small blowouts due to high-pressure pockets of nitrogen being encountered at shallow depths where the mud head is insufficient to hold the gas down. To minimize the danger and losses due to these blowouts, one company worked out the following system—the mud line was shortened and a section of pipe larger than normal mud outflow line inserted just ahead of the screen. This enlarged section, in addition to providing space for expansion of gas carried in the mud stream, was also opened at the top with a wide cut-away section or slot. A gas-laden charge of mud, reaching this point, would seem to explode, most of the gas and a little mud being blown vertically through the slot, saving the screening equipment just beyond from the force of the blast. A quick-closing valve was installed in the mud flow-line, at a convenient point below the derrick floor, the weighted arm of the unit being normally held up by means of a chain supported in a quick-release fastening set into the derrick floor. Since positive, quick closing was of more importance than positive seal against all flow, the packing on the stem of this valve was left loose enough to insure that binding at this point would not defeat the snap action of the weight in closing it.

While drilling through the danger zone the master bushings in the rotary are locked in place to prevent their being literally blown from their socket by the force of the blow up along the drill-string. Since modern rotary tables provide some means of securing the bushings within the table, this step merely involves provision of proper locking bar and its use through the danger zone. When the blowout is approached, a close watch is kept on the flow-line vent and, if a blowout is indicated, the locking chain is released and the quick-acting valve is closed. This eliminates any possibility of damage to the mud-conditioning machinery and confines the blowout to the cellar area. The drilling fluid is, of course, blown straight up against the locked master bushings—and falls back into the cellar to be recovered. A. H. N.

739. **Patents on Drilling.** A. Boynton. U.S.P. 2,314,867, 30.3.43. Appl. 22.9.38. —Semi-threadless drill stem.

W. B. Noble and J. E. Hoffoss. U.S.P. 2,314,947, 30.3.43. Appl. 23.11.40.—Core-bit with roller-cutters below the slush passage-ways.

W. D. Mounce. U.S.P. 2,315,127, 30.3.43. Appl. 12.10.39.—Resistance thermometer adapted to be lowered into a hose-hole.

E. J. Roach and E. F. Cooke. U.S.P. 2,315,134, 30.3.43. Appl. 3.11.41.—Well control head for oil.

A. R. Maier. U.S.P. 2,315,157, 30.3.43. Appl. 14.6.41.—Draw-works.

S. A. Scherbatskoy. U.S.P. 2,315,355, 30.3.43. Appl. 30.4.40.—Well surveying method and apparatus using a detector of radioactivity in the drill-stem.

J. H. Wilson. U.S.P. 2,316,304, 13.4.43. Appl. 16.1.40.—Mast pole derrick of the portable type.

D. G. C. Hare, U.S.P. 2,315,329, 13.4.43. Appl. 18.6.40. Subsurface prospecting by investigating the formation surrounding a bore-hole by means of a source of neutrons.

R. G. Piety. U.S.P. 2,316,361, 13.4.43. Appl. 17.3.41.—Method and apparatus for surveying wells by determining the distribution of radioactive material in the earth surrounding the well.

A. B. Canon. U.S.P. 2,316,402, 13.4.43. Appl. 19.8.40.—Cementing wells and using a packer.

L. R. Downing. U.S.P. 2,316,409, 13.4.43. Appl. 5.12.41.—Oil-well straightener to be used above a drill-bit.

R. E. White, W. E. Liljestrand and A. S. Volpin. U.S.P. 2,316,480, 13.4.43. Appl. 3.8.40.—Flat-top slush pump-valve.

R. E. Fearon. U.S.P. 2,316,576, 13.4.43. Appl. 14.8.40.—Well-surveying method and apparatus using an electric circuit with an ionization chamber. A. H. N.

Production.

740.* Mid-Continent Reconditioning Practices Entering New Era. Part 1. L. E. Elkins, R. H. Smith, L. F. Peterson, and P. P. Manion, Jr. *Oil Wkly*, 29.3.43, **109** (4), 22. *Paper Presented before American Institute of Mining and Metallurgical Engineers.*—In order to determine if reconditioning is desirable or possible, certain specific questions must be considered. They may be generalized as follows:—(1) Is the well in good "mechanical" condition, or is some plugging agent or extraneous fluid restricting, in some manner, the otherwise normal flow of oil or gas? (2) Is there sufficient oil or gas remaining in the area of drainage influence of the well in question to justify reconditioning operations? (3) At what interval within the section is the objective oil or gas zone located? (4) Is there sufficient reservoir energy to supply the motivating force to move this oil towards the well-bore? (5) Is the distribution of fluid (oil, gas, and water) in the section of the reservoir around the well, in relation to the permeability profile, such that the desired oil or gas can be selectively withdrawn if necessary? (6) What mechanical operation is required to accomplish the objective? (7) Are the physical characteristics of the pay section, reservoir pressure, and the shape of the penetrating well-bore such that the mechanical operation can be accomplished? (8) Would reconditioning be economic?

Reconditioning operations may be divided into three general classifications, as follows: (1) The problem of eliminating extraneous forces and their restrictive action on the normal flow of oil and gas. (2) The problem of increasing the drainage efficiency of a well by either extending its vertical or lateral sphere. (3) Means of reconditioning wells to establish selective withdrawal, and thus conserve energy or reduce lifting expense through reduction of free gas or excessive water production. Part 1 of the paper deals with class (1), the other two classes being discussed in parts 2 and 3.

The above restrictive forces are primarily plugging agents. They become stuck to, or bridged in, the natural channels of permeability. Many times the restricting action is obvious because of unusual decline in productivity, and its removal is simple, and requires no special innovation. The use of sand-pumps, special bailers, reverse circulation processes, acid-jet guns, wall-scrapers, under-reamers, application of heat, and such, all have their field of application in removal of plugging agents in open hole and sometimes behind the pipe. If the operation is not one of the relatively simple cleanout type as listed above, more basic data and more specialized technique may be required. Complications develop many times when pipe is set through pay formations, or if the plugging agent penetrates into, or is deposited deep in, the channels of permeability. Then the reconditioning either requires removal of the plugging agent by abrasion, or scraping, or by solvent action, or it may be necessary to create new permeable channels by shooting or its equivalent. Plugging back, side-tracking, and re-drilling the pay section may sometimes be justified if the plugging agent is deposited by the oil-stream as it converges on the well-bore. Case histories have been prepared to illustrate how two of these typical problems develop and how they can or might be solved. These case histories are presented with full illustrations. A. H. N.

741. Some Factors Affecting the Economics of Gas Cycling Plant Design. R. L. Huntington. *Refiner*, April 1943, **22** (4), 100–103.—There are a number of engineering studies to be made before final consideration is given towards the design of a condensate and natural-gasoline-recovery plant. (1) The estimation of the condensate, natural gasoline, and dry gas reserves in the field, based on geological and physical test data. (2) An electrolytic model study of the field in order to determine the arrangement of input and producing wells for the best flooding pattern. (3) A study of market outlets for liquefied and gaseous products.

Owing to the heavy demands for the lighter hydrocarbons, the trend in the construction of condensate-recovery plants has been towards the installation of centralized oil-absorption plants. Each field presents its own problems, such as that of the selection of optimum operating pressures and temperatures, depending on the composition of the reservoir fluid to be processed. Other factors, such as the balancing of gas-compression cost against the recovery of condensate and natural gasoline, are

discussed. Mathematical derivations are given for the determination of the optimum inter-stage pressures whenever the ratio of discharge pressure to intake pressure runs too high for economical single-stage operation. A. H. N.

742. Salt-Water Disposal in Kansas. N. Williams. *Oil Gas J.*, 1.4.43, **41** (47), 29–30.—The fields discussed produce very large amounts of water, and State regulations now prohibit impounding of water or other disposal except in wells. Disposal of water in wells has presented a number of problems, both physical and economic. Not only has it been necessary to provide wells capable of taking the water in sufficient volume, but special precautions have been necessary to insure that injected water would not enter any formation in which fresh-water supplies or oil production would be endangered. Also involved has been the adoption of suitable methods and facilities for handling and treating the water. Chief concern, in view of the comparatively low potential oil recovery remaining in some of these fields, has been the need for holding costs of disposal to an absolute minimum. Principal formations used at this time for water injection are the Arbuckle lime, the granite wash, and the Reagan Sand, which lies below the Arbuckle. The Dakota Sand has been used to some extent in certain areas, but this is a shallow horizon, and is sometimes a source of fresh-water supply. A survey is now under way to determine the extent of potentialities of this sand for water disposal. The Arbuckle lime, usually found around 3250 ft., is the main oil-producing horizon of the area, but it has a very active water drive and is a large producer of water, and with water returned to down-structure locations no complications arise. The Reagan Sand is particularly suitable sand in those fields where it is known not to carry oil or gas. Although various shallow sands have been used, injection to them is rapidly being discontinued in favour of the lower horizons.

The method used is discussed. A. H. N.

743. Catwalk Facilitates Servicing of Heavy-Duty Pumping Unit. N. Williams. *Oil Gas J.*, 1.4.43, **41** (47), 40.—The maintenance connected with the walking beams of heavy-duty pumpers presents a difficult problem of safety. An operator in the Oklahoma city field has solved the problem by providing a catwalk which extends outward in each direction from the Sampson Post position to the ends of the walking beam. It is supported in the structure of the pumping derrick by the side of the walking beam, and at a height convenient for the pumper to lubricate or adjust the working parts. That half of the catwalk which extends inside the derrick to the beam-head assembly over the well is supported on a pivot hinge at the centre point, so that it folds upward against the back of the derrick when not in use. This places it out of the way when the well is in operation, or when rods or tubing are being pulled.

The folding section swings upwards out of the way automatically by means of a counterweight arm extension, which also holds it in its upward position. It is balanced so that only slight effort is required to lower it. The weight of a man holds it downward in working position. The back section extending to the pitman bearings is stationary, and is supported at its outward end by two cables, one on each side, secured into the derrick above, and by two bracing arms on the underside. A. H. N.

744.* Gas-Oil Ratio Calibrations Used to Measure Gas in Gas-Lift Wells. D. Attaway. *Oil Wkly*, 19.4.43, **109** (7), 18–20.—Measuring gas-flow records into and out of wells on intermittent gas-lift by means of seven-day recording charts gave one company a difficult problem. The cause of this condition was the fact that gas-lift units were equipped with time clocks or automatic injection devices to operate at set intervals, such as 15-minute periods, 10-minute periods, etc. When the valve opened to admit a charge of gas to the well, the gas-flow reached peak velocity immediately and the differential pen swept out to recording position in almost a straight line. Usually the injection period consumed only 2 or 3 minutes and the automatic valve shut off completely, causing the differential pen to fall back almost instantly down the same line it had recorded in ascending. Such a record was certainly unreadable. Dampening plugs and other devices were unsatisfactory, as they actually retarded differential pen movement.

The solution of the problem selected was the use of gas–oil ratio tests. Several special-type clocks were purchased having devices for setting the rotating time at 1-, 3-, or 6-hr. intervals. The process involved a tester or meter man making a visit to the

lease using gas-lift and removing the 7-day clock from the lease meter. A "fast" clock was installed and a chart placed on the meter. The meter was tested for "zero" and then placed in service. The oil-storage tank into which the well was producing was then gauged. Both the injection-gas meter and the production-gas meter could be fitted with the special clock for the test period. If the clock was set for a 1-hr. rotation and the well intermitter operating on a 15-min. schedule, the chart would secure a record of four injections. As the orifice meter clock is running at a very fast speed, the differential hand, in moving out across the chart, covers some distance. If the injection period is as short as 3 or 4 min. almost $\frac{1}{15}$ of the chart surface passes beneath the differential pen during the injection. Such a record is very readable and accurate.

In order to secure an average and representative record of the well's behaviour and operation, a chart might be taken every hour for 3 hrs. In cases of varying recordings, the test might be extended to 6 hrs. Wells having injection periods 30 mins. apart might use a clock rotating in 3 or 6 hrs. Such a clock speed will be ample to record a very readable differential record. At the conclusion of the test, whatever its period, a gauge must be taken of the well's production during the period. Having secured readable charts and knowing the well's exact production, it is possible to calculate the amount of gas required to lift a barrel of oil. Using the production-gas meter, the amount of gas produced with each barrel of oil can be determined.

Typical examples are given. A. H. N.

745.* Mid-Continent Reconditioning Practices Entering New Era. Part 4. L. E. Elkins, R. J. Smith, L. F. Peterson, and P. P. Manion, jr. *Oil Wkly*, 19.4.43, **109** (7), 21–28. *Paper Presented before American Institute of Mining and Metallurgical Engineers.*—During the natural evolution of petroleum technology, the problem of proper use and conservation of reservoir energy has gradually advanced to a front-line position. Although conservation is usually found enveloped in studies of the reservoir as a whole, the individual well is the means through which conservation must be achieved. The flow of fluid into and from the well results in an expenditure of energy which, in many reservoirs, is at least partly irreplaceable. Therefore the problem of selective withdrawal is one which has rapidly come into focus. In reality, selective withdrawal can be applied in two general ways. It can often be applied to a reservoir as a whole—that is, oil or gas production may be restricted to certain areas in a field in order to limit water or free gas production, an excess of either often representing inefficient use of reservoir energy. This type, to be effective, requires unitization or some type of co-operative operation.

The other type of selective withdrawal is confined to the individual well and, to be realized, frequently requires complex workover operations. This is discussed in great detail under the headings of water shut-off and the exclusion of gas. Ordinary and squeeze cementing are discussed. A number of typical workover cases are quoted and discussed.

It is concluded that the technique of reconditioning oil-wells is rapidly approaching the stage where a minimum of guesswork has to be relied upon to solve the individual problem. This has been brought forth by the initiative and co-ordinated efforts of oil-producing companies and active service companies.

The paper is followed by a discussion on certain of the points raised—mainly on water shut-off jobs. A. H. N.

746. Loco-Hills Pressure Project Indicates Increased Recovery. G. M. Wilson and F. Briggs. *Oil Wkly*, 19.4.43, **109** (7), 30.—Early realizing that co-operation among themselves would mutually benefit each operator through prolongation of the life of the field, a conservation programme involving a pressure-maintenance project was put into effect in October 1941 in the Loco Hills Field of New Mexico. With the exception of two operators in the field, an association of Loco Hills producers carries on this conservation programme as a non-profit making, incorporated organization, employing an operating staff consisting of a superintendent, engineers, and clerical personnel. Since the pressuring operations were begun, the bottom-hole pressure and gas–oil ratio tests have indicated a trend towards a maintenance or improvement of these factors. The average bottom-hole-pressure curve for the field began to level off in March 1942, and this condition has been maintained to such an extent that operators,

previously estimating 4500 brls./acre, now believe recovery will be in the neighbourhood of 10,000 brls./acre.

The Loco Hills Field is described, together with some of its history and organization.

The most recent survey taken, in January 1943, shows a gain on reserve pressure on twenty-four wells over the previous survey of September 1942. In October 1941, when the plant was put in operation, there were twenty-seven pumping wells in the field. During 1942 only two additional wells were placed on the pump. These two wells were making a small amount of water. Several of the pumping wells have shown an increase in production, and it is the general opinion of many of the operators that, without repressuring, many more wells would have been pumping by the end of 1942. A. H. N.

747.* **Systematic Measures Would Increase Production of Old Shallow Wells.** J. Schmer. *Oil Wkly*, 26.4.43, **109** (8), 33.—To increase the production from old shallow wells certain instructions are given. (1) Increase or restore the gas pressure in all wells through injecting compressed gas or air in a few carefully selected input wells. (2) Clean, systematically, well after well, starting with the oldest and lowest producing wells, in the manner prescribed in the paper, which involves pulling the pump, cleaning the sand-face with a tool, and heating the formation by hot oil or steam. (3) If the results, after applying all the above measures, are not satisfactory, shoot the oil sand-stone, but only if this formation is " free " (below the casing), or if the casing can be moved higher without much difficulty and without danger of opening the water. The results are often sensational, and are well worth trying. Some wells have increased their production 5000% with these methods. (4) In the event that shooting was not successful or was impossible to apply for technical reasons, deepen the well after consulting an experienced geologist who is familiar with this terrain. (5) If production does not increase, salvage casing and drill new wells. A. H. N.

748. **Patents on Production.** A. Boynton. U.S.P. 2,314,868, 30.3.43. Appl. 8.12.39. Flowing device, tubing and casing-flow for gas-lift.

A. Boynton. U.S.P. 2,314,869, 30.3.43. Appl. 8.12.39. Differential stage-lift flow-device for gas-lifting of liquids.

H. M. Stevenson. U.S.P. 2,315,023, 30.3.43. Appl. 10.6.39. Water-drain for floating roof tanks.

J. H. McKean and E. K. McKean. U.S.P. 2,315,069, 30.3.43. Appl. 17.4.40. Scraper for removing paraffin deposits from the interior of a conduit.

S. Bullum. U.S.P. 2,315,152, 30.3.43. Appl. 14.10.40. Pump-pull rod adjuster for pumping-wells.

A. Germany. U.S.P. 2,315,414, 30.3.43. Appl. 8.7.41. Sucker rod coupling using overlapping pins and a sleeve.

J. C. Luccous. U.S.P. 2,315,437, 30.3.43. Appl. 27.11.41. Perforator for well-pipes using a knife.

A. M. Baudy. U.S.P. 2,316,216, 13.4.43. Appl. 16.11.40. Apparatus for taking samples of fluid from wells.

B. Henderson. U.S.P. 2,316,429, 13.4.43. Appl. 7.4.41. Inverted cylinder pumping unit for oil-wells.

L. Trager. U.S.P. 2,316,492, 13.4.43. Appl. 26.8.41. Fluid-meter of the nutating type.

R. Tipton. U.S.P. 2,316,494, 13.4.43. Appl. 12.5.41. Oil-well pump-controller where the prime mover is an electric motor.

H. T. Kennedy. U.S.P. 2,316,596, 13.4.43. Appl. 4.11.38. Shorting wells for increasing their productivity.

P. M. Evans. U.S.P. 2,316,679, 13.4.43. Appl. 22.12.41. Coupling device for well apparatus such as pumps.

R. R. Thompson and W. D. Mounce. U.S.P. 2,316,728, 13.4.43. Appl. 17.10.40. Gun perforator for wells. A. H. N.

Synthetic Products.

749.* Properties of Rubber Solutions and Gels. M. L. Huggins. *Industr. Engng Chem.*, 1943, **35**, 216.—From published experimental work and thermodynamic equations, a series of constants have been calculated for various natural and synthetic rubbers and a large number of solvents, which enable the molecular weight to be determined from osmotic pressure and cryoscopic data. J. W. H.

Refining and Refinery Plant.

750. A Method by Which Refining Plants May Accumulate Scrap Metals Using Sound Business Principles. G. M. Dent. *Refiner*, March 1943, **22** (3), 65–67.—A tally system is described. The economics of salvage are also discussed. Estimates of the value of materials taken into the salvage yard are based on the percentage of probable stores valuation which will be assigned to the material on completion of reconditioning. An arbitrary standard "percentage of original value" of 80% for all reconditional material delivered into stock is used, with the following exceptions: (*a*) New material broken or damaged during installation and sent to the salvage yard for repair is returned to stock at 100% of original value. (*b*) Pipe and fittings under 2 ins. in size and bolts and nuts and similar small material are returned to stock at 100% of new value. (*c*) Materials which cannot be reconditioned to meet specifications of the service for which they were originally purchased and used, but can be substituted in other services, the requirements of which are not so exacting, are returned to stock at 80% of the original value of materials for which they can be substituted when reconditioned, and not at 80% of their own original value. Examples are furnace tubes which are removed due to the walls having reached the minimum thickness allowed for furnaces, but which can be used further as a substitute for standard pipe- or 150-lb. steel valves which can be reconditioned for 125-lb. cast-iron service, but are not suitable for further use in services where 150-lb. steel is required. A. H. N.

751. Seal-Oil Systems for Refinery Centrifugal Pumps. I. Taylor. *Refiner*, March 1943, **22** (3), 68–72.—In a centrifugal pump the principal parts of a mechanical seal are the two ring-shaped seal-faces which both encircle the shaft side by side, as two rings on a finger. When the pump is running, one ring is rotated by the shaft against the other, which is stationary—a construction somewhat similar to a single-collar thrust-bearing, but without appreciable thrust. These rings or collars and other parts are so positioned in the packing box that the only possibility of liquid escaping through the box would be by a separation of the seal-faces. But this must not happen, so the two rubbing seal-face surfaces are constantly held together, sometimes by hydraulic pressure, sometimes by a coil-spring or a set of small springs arranged to press one of the rings against the other axially. Springs are used to prevent the formation of any gap between the seal-faces while the pump is stopped, and to help prevent separation which might occur due to end-play or whipping of the shaft while running. In some cases the springs rotate with the shaft, holding the rotating collar axially against the stationary collar. (The latter often serves also as the pump-throat bushing or as the packing-box gland.) In other instances, stationary springs may press the non-rotating collar against the rotating one which is locked on the shaft. In either case there must be provision for a slight amount of axial sliding of one of the seal-ring collars to maintain the closure constantly. To prevent any liquid from leaking past the seal through this joint of sliding, it is the practice to arrange the sliding member with a single ring of rubber or neoprene, or sometimes a metal "piston ring," to act as a flexible gasket. Lubrication is usually required, and the lubricant is called "seal oil."

The following is a list of the various sealing methods frequently used for centrifugal pumps in refinery services: (1) Several compressible packing rings, divided into two sections by a lantern ring (sometimes called a water-seal cage), which permits introduction of a lubricant near the centre of the packing space. (2) Compressible packing rings and lantern ring, the same as arrangement No. 1, plus a special connection to a labyrinth-type throat bushing or pressure-reducing device at the inner end of the box, to permit either—(*a*) *Bleeding out* a small amount of liquid from the pump to a lower

pressure (to reduce pressure on the packing rings), or (*b*) *Injection* of a different liquid from the outside (so that packing rings will not be subjected to the liquid being pumped). (3) Single mechanical seal, usually having the rotating unit inside the box and surrounded by the liquid being pumped. Sometimes arranged with a groove in the stationary-seal face for introduction of a lubricant to the seal faces only. (4) Double mechanical seal, with both rotating units inside the box surrounded by a lubricating seal oil, the seal oil maintained at a pressure slightly higher than the internal pump pressure which acts at the packing-box throat bushing. Each type is illustrated and discussed in some detail.

The replacement of packing by double mechanical seal in centrifugal pumps necessitates the purchase of such a considerable amount of additional special equipment that a refiner might question the avisability. However, mechanical seals that have given very fine service for three or four years are still running, and have operated almost continuously with a leakage of only ¼ pint/24 hrs./packing box, after "wearing-in." This is very satisfactory progress, justifying their use and showing that much has been accomplished towards eliminating some of the trouble, expense, hazard, and unsightliness which go with the use of packing. A. H. N.

752. Automotive Engines Adapted to Water Pump Drives. Anon. *Refiner*, March 1943, **22** (3), 73–75.—The paper describes the conversion of used truck and bus engines to stationary engines used to pump water for cooling-tower purposes. Support bases were made of channel steel. Connecting each engine to its pump was done with a conventional flexible coupling eliminating the original clutch and gear-box of the bus engine. A short stub-shaft, the size in diameter to match the companion section of the flexible coupling, was welded to a circular plate of heavy steel trimmed to fit in the depression in the centre of the flywheel and bolted to that member of the engine and the crankshaft flange with adequate cap screws. The stub-shaft and flange welded to it was placed in a jib to obtain the necessary straightness, and afterwards faced in a lathe for finishing. The remainder of the connecting job resolved itself into routine mechanics, and was done in the same manner as that accomplished with any other power drive. The exhaust manifold was changed into a water-jacketed unit.

A. H. N.

753. Protective Lighting of Oil Refineries. R. M. Swetland. *Refiner*, March 1943, **22** (3), 77–79.—The paper deals with lighting of refineries where no permanent blackout is imposed, although rapid emergency blackout is contemplated. The principal objectives of protective lighting for oil refineries are: (1) To assure adequate visibility and convenience to guards under the most adverse weather conditions, (2) to assure this visibility despite possible intermittent lamp outages, and (3) to assure maximum discouragement to the would-be intruder. There are two generally accepted and proven methods by which refineries may be lighted efficiently for night protection. By the use of boundary-fence lighting, or through the use of area lighting. The physical make-up of the refinery and its daily working schedule are usually deciding factors in the final choice of the most effective protective-lighting system. If the plant areas are enclosed by a boundary fence with little or no plant activity at night, fence lighting should constitute an effective solution to the problem. Whether or not a boundary fence exists, properly engineered area flood-lighting will offer satisfactory night-time protection against illegal entry to the property, and will serve the additional purpose of allowing efficient operation of the plant at night. The design of such systems is briefly studied. A. H. N.

754. Compressor Maintenance. Anon. *Refiner*, March 1943, **22** (3), 80–84.—Detailed description is given of the appropriate precautions to be taken and practices to be adopted in the maintenance of compressors to yield efficient working for maximum periods. Starting of new or old overhauled compressors is discussed in full. Systems of inspection are recommended. Lubrication is studied. As many as three different types of oil may be required by a reciprocating compressor, one type for the compressor cylinders, another for the bearings of the driving gear, and a third for the power cylinders, provided the source of power is steam, diesel, or gas engine. Oil intended for compressors of the single-acting trunk piston type must be suitable for both the

compressor cylinders and the running gear, and must be of the type known as compressor-cylinder oil with specifications suitable for the particular machine. Double-acting piston-type compressors, in which the frame, running parts and the compressor cylinders are completely separated, require cylinder oil for the compressor cylinders and crankcase or bearing oil for the running gear. Specifications for oils for the compressor and the steam cylinder are given.

Centrifugal compressors and exhausters require bearing lubrication only, and in overhung units with no bearings of their own only the driving mechanism is lubricated. Ball or roller type anti-friction bearings on small pedestal or multi-stage units require grease or oil in the usual manner. Larger and higher speed units generally have pressure-lubricated sleeve bearings.

The maintenance of auxiliary equipment, *e.g.* piping, coolers, valves, etc., is discussed.

A. H. N.

755. The Stabilization of Crude Oil. Part II. F. L. Kallam. *Refiner*, March 1943, **22** (3), 89–94.—The review of stabilization by years begun in Part I is continued in this part of the paper, beginning with 1937 and ending with 1942. The conclusion reached is that it is obvious that crude-oil stabilization has made some progress during the past sixteen years, but the record indicates that the oil industry has yet failed to grasp fully the economic possibilities of the process. This is to say that complete understanding is still lacking as to the benefit resulting from controlled evaporation brought about by means of fractionation. It is necessary to realize first that only through fractionation is it possible to remove from the oil the light undesirable fractions and still retain all of the heavier and desirable constituents. In accomplishing this retention by fractionation it is usually possible to increase both the volume and the gravity of the oil sold without increasing the evaporation tendency in the lease tanks. This follows from the fact that in controlled removal of the light hydrocarbons, the percentage of the remaining heavier fractions can be increased without disturbing or changing the value of the vapour pressure of the original oil.

The problem of whether or not to stabilize the crude oil calls for very careful engineering study, with the overall interests of the company kept foremost in mind. It is apparent that the subject of oil and gas separation is not one to be decided by any one department or individual, but rather by its relationship and importance to the entire project of oil and gas production. Every problem of crude-oil stabilization must be solved for the particular oil and gas characteristics of the field considered. The question of temperatures and pressures of separation are involved, to say the least, and are further complicated by the allied subject of stages to be employed. The final selection will be governed by the field conditions, methods of production and the physical characteristics of the oil and gas. About the only generalization possible is that one separation should be conducted at the highest optimum pressure. This will permit economic venting of the ethane and lighter materials from the oil with the minimum loss of desirable and valuable hydrocarbons.

Under certain field conditions, the installation of a crude-oil stabilizer unit can be arranged to eliminate the necessity of a natural-gasoline plant. In most cases, however, the crude-oil stabilizer will fit conveniently into an existing operation involving the conventional gasoline plant. It should always be remembered that one of the advantages of the crude-oil stabilizer is that it results in the saving of gas-compressor capacity. This results from the fact that vapours removed from the crude oil in the stabilizer are made available at a higher pressure than would be the case if they were released in the ordinary low-pressure trap or at the lease tanks. Producing stabilized oil into lease-tanks does away with weathering losses and automatically eliminates the need for any form of vapour-recovery system. Similar savings will result at all tank farms and in handling through the pipe-line and the refinery.

In fields where the oil production is accompanied by hydrogen sulphide, the crude-oil stabilizer will serve as an excellent scrubber and economic remover of this corrosive agent. Likewise, by adequate design, the stabilizer can lend itself to the problem of dehydration of the oil and the removal of salts and other sediments. A. H. N.

756.* Bead Catalyst. Anon. *Nat. Petrol. News*, 17.3.43, **35** (11), 18.—The production of a new synthetic catalyst in the form of small translucent spherical particles is announced. The new material is claimed to increase yields by 13–30% and to produce

such an improvement in octane number that the available power output of an aero engine is increased by 23–35%. The catalyst is claimed to be robust and to possess exceptional catalytic activity with little loss in practice. Existing plants are said to be easily adapted for the use of "beads." H. G.

757. **Method of Design of Steel Stacks and Foundation.** S. Levine. *Refiner*, April 1943, **22** (4), 116–117.—A typical problem, which the author had to solve in practice, is presented, and the steps taken in solving it are summarized. A. H. N.

758. **Effective Treating for a Small Plant.** Anon. *Refiner*, April 1943, **22** (4), 118–119.—Solution of treating problems in the small refining plant are difficult to accomplish for the reason that research and laboratory facilities are not comparable with those of the larger plants. The method used in one of the small plants of the west coast came into use through trial-and-error progress, so that now caustic washing of cracked distillate is employed in two stages, the first for the removal of H_2S and the reduction of mercaptan content in the second. The caustic solution of this second stage also serves to wash the vapour charge to the polymerization plant for H_2S reduction. The plant output is doctor sweetened. The treating method is of continuous operation with treating solutions regenerated. The plant is described and illustrated. A. H. N.

759. **Caustic in Vapour Stream Halts Corrosion.** Anon. *Refiner*, April 1943, **22** (4), 123.—When excessive corrosion was found in the vapour line from the dephlegmator and in condensers in one of the west coast natural gasoline plants, investigation established that the cause was acidity in the vapour stream and its resulting condensate. The fact that in refining it is common practice to introduce alkaline solutions into vapour lines at many points, was in part responsible for the selection of a caustic injection as a means of neutralizing the destruction of sulphur compounds in this instance. The major problem was in the method introducing the solution. Because of the lack of desirable equipment, such as a proportioning pump or other force-feed appliance, recourse was taken to the method used in plants involving a blow-case, such as is seen in refiners manufacturing various grades of distillates and lubricating stocks. The system should, obviously, be as simply made as practicable, so that workers not familiar with gasoline-plant operation who might replace those inducted into the armed forces, might readily grasp the significance of the process and operate it without involved calculations and frequent manual manipulation.

The process is described. A. H. N.

Chemistry and Physics of Hydrocarbons.

760.* **Vapour–Liquid Equilibrium of Methylcyclopentane-Benzene and other Binary Aromatic Systems.** J. Griswold and E. E. Ludwig. *Industr. Engng Chem.*, 1943, **35**, 117.—Boiling point, relative volatility, and vapour–liquid equilibrium data are presented for the binary mixture methyl*cyclo*pentane-benzene. These data show that the mixture deviates appreciably from Raoult's Law and that a minimum boiling-point azeotrope occurs at 71·5° C. containing 90 mol.-% methyl*cyclo*pentane. A discussion of the results of other workers shows that benzene forms an azeotrope with *cyclo*hexane of boiling point 70° C. containing 50 mol.-% benzene, and that, although no azeotrope of benzene with *n*-hexane has been proved, it is probable that one exists having a boiling point only 0·1° C. below the boiling point of *n*-hexane containing approximately 3% benzene. No azeotropes of toluene with methyl*cyclo*hexane, *n*-heptane or *n*-octane are formed, but the relative volatilities decrease abnormally as the compositions approach the pure low-boiling compound.

These deviations from Raoult's Law explain the failure of good fractionation equipment to resolve six- and seven-carbon petroleum fractions into pure components when aromatics are present. J. W. H.

761.* **Solubility of Hydrogen in *n*-Butane.** E. E. Nelson and W. S. Bonnell. *Industr. Engng Chem.*, 1943, **35**, 204.—The solubility of hydrogen in *n*-butane has been determined over the temperature range 24–116° C. and at pressures up to 100 atoms

Full details of the experimental technique employed are given, and from a plot of the bubble-point pressure against temperature it is shown that a minimum occurs for mixtures containing 3–4% hydrogen. The significance of this result is to indicate the existence of a region of isobaric retrograde recondensation at temperatures far below the critical region of the mixtures. J. W. H.

762.* Liquid-Vapour Equilibrium Compositions in Hydrogen Chloride-*n*-Butane System. J. H. Ottenweller, C. Holloway, and W. Weinrich. *Industr. Engng Chem.*, 1943, **35**, 207.—The equilibrium liquid and vapour composition of the system hydrogen chloride-*n*-butane has been determined over the temperature range 70–180° F. and at pressures up to 550 p.s.i. Complete details of the experimental and analytical technique are given, and the data are presented in the form of bubble and dew-point curves and in the form of K-values at constant temperature. The data indicates that this system is in general agreement with Raoult's Law over the range investigated. On the basis of similarity between this system and the hydrogen chloride—propane system the data have been extrapolated up to pressures of 1000 p.s.i. At pressures above 600 p.s.i. it is shown that retrograde vapourization can occur on isothermal compression. J. W. H.

763.* Surface Tension of Methane-Propane Mixtures. C. F. Weinaug and D. L. Katz. *Industr. Engng Chem.*, 1943, **35**, 239.—The surface tension of mixtures of methane and propane have been determined over the temperature range 5–194° F. and at pressures from 40 to 1500 p.s.i. A description of the experimental techniques employed are given, and the results have been correlated in graphical form, which reproduces the data to within 0·1 dyne/sq. cm. It is shown that in the critical region liquids have very low surface tensions. J. W. H.

764.* Vapour-Liquid Equilibria of Close-Boiling Hydrocarbons. J. Griswold. *Industr. Engng Chem.*, 1943, **35**, 247.—Re-examination of the vapour–liquid equilbria of the systems *n*-heptane–methyl*cyclo*hexane has shown that this mixture may not be assumed to be ideal, and that the previously accepted value of 1·07 for the relative volatility must be revised to 1·083. The basis of the revision of this value is the verification of Bromiley and Quiggle experimental equilibrium data, which had been rejected by Beatty and Calingaert. The basis of the experimental technique employed for this verification was the determination of the relative volatility by means of a fractionating column containing a known number of theoretical plates as tested with other mixtures. By this method the relative volatility of the binary mixture *n*-heptane–*iso*octane has been determined, and found to be 1·023. This method is of great value in determining the relative volatility of closely boiling mixtures. It is concluded that ideality is only reached between two compounds of the same homologous series. J. W. H.

765. Chemical Notations. P. H. Faust. *Refiner*, March 1943, **22** (3), 85–86.—An extremely elementary treatment of structural formulæ of hydrocarbons is presented. A. H. N.

766. Some Physical Properties of Butadiene and Styrene. L. A. Wood and C. F. Higgins. *Refiner*, March 1943, **22** (3), 87–88.—Both the properties and the sources of information are given for 1 : 3-butadiene and styrene. The properties are given in metric and British engineering units. The following properties are tabulated: molecular weight, normal boiling point, freezing point, vapour density (for 1 : 3-butadiene only) and liquid density at different temperatures, thermal expansion, vapour pressure, and a formula for calculating it at various temperatures, rate of change of boiling point with pressure, latent heat of vaporization, heat of fusion, heat of formation of vapour and of combustion (for 1 : 3-butadiene only), specific heat, refractive index, rate of change of refractive index with temperature (for styrene only), dimensions of unit cell of crystalline 1 : 3-butadiene, surface tension of styrene and limits of flame propagation for both. A. H. N.

767. Petroleum as a Source of the Aromatic Hydrocarbons. A. W. Trusty. *Refiner*. April 1943, **22** (4), 95–99.—Production of aromatics from coal is first discussed, and this is followed by a concise report on the occurrence of aromatics in petroleum.

Scarcely any aromatic hydrocarbons are found in natural gases. Small amounts begin to appear in the lighter liquid fractions from crude oils, and the aromatic content of the heavier fractions of a naphthenic-base crude oil increases considerably in volume. Rarely can a crude oil be found with sufficient aromatics present to justify commercial separation. For the production of aromatics from petroleum sources, it is necessary to use some thermal- or catalytic-cracking process. The most thorough investigation of the hydrocarbon constituents of a crude oil probably was the work done by the Bureau of Mines in A.P.I. Project No. 6. The amount of aromatic hydrocarbons present in Oklahoma crude oil is shown—benzene, 0·08%; toluene, 0·30%; *o*-xylene, 0·04%; *o*-xylene, 0·12%; *m*-xylene, 0·12%; ethyl benzene, 0·03%.

Bureau of Mines preliminary work on East Texas naphtha showed the following aromatic content: Benzene, 0·04%; toluene, 0·46%; ethylbenzene, 0·14%; *n*-propylbenzene, 0·04%; xylenes, 0·56%. Canadian workers have investigated the aromatic content of two Canadian crude oils, and found the following: benzene, 0·28 and 0·32; toluene, 1·07 and 2·00; and xylene and ethylbenzene, 1·45 and 2·50 respectively.

The following table is reproduced from a paper by Garner and Evans:—

Crude Oil.	Yield of Gasoline.	Benzene.	Toluene.	Xylene.	Total Aromatics up to 32° F.
Seminole, Okla. . .	36	0·1	0·6	1·5	2·2
Grosny, Russia . .	13	0·4	1·4	2·0	3·8
Mexican . . .	10	0·5	1·5	3·0	5·0
Panuco . . .	3	0·7	1·9	4·0	6·6
Venezuelan . . .	7	0·9	1·5	3·7	6·1
Colombian . . .	20	0·2	0·8	1·3	2·3
California . . .	20	0·6	2·4	3·7	6·7
Persian . . .	30	1·5	4·5	5·1	11·1
Heavy Smackover, Ark..	—	0·15	0·4	1·5	2·05
Roumanian . . .	—	1·8	3·6	4·2	9·6
Borneo . . .	—	7·0	14·0	15·0	36·0

The rest of the paper deals with chemical methods used for preparing aromatics and with their uses in synthetic rubber, explosives, etc. A. H. N.

768. Some Uses of Infra-Red Spectroscopy for Hydrocarbon Analysis. R. R. Brattain. *Refiner*, April 1943, **22** (4), 104–110. *Paper presented before California Natural Gas Association.*—Three different types of energy change within a molecule give rise to its spectrum. Changes in the electronic energy of a molecule cause either emission or absorption of radiation in the ultra-violet or visible regions. Examples of this, often used for analytical purposes, are the absorption bands of aromatic compounds in the 2400–2700 A. range. Absorption in the ultra-violet region can be and is being used as a powerful analytical tool. However, paraffins and mono-olefins do not have characteristic absorptions, caused by electronic energy changes, in a wave-length region easily accessible. Practically all of their absorption is at shorter wave-lengths than 2000 A. and, consequently, they cannot be studied unless vacuum spectrographs, either prism or grating, are used.

Spectra caused by changes in the rotational energies of molecules appear in the far infra-red. This region, the short wave-length limit of which is usually taken as 30μ, is not used for analysis because the experimental technique is too difficult.

The spectral region which is discussed in this paper is referred to as the near infra-red, and extends from 2μ to 30μ. The actual analyses discussed only make use of absorption between 3μ and 15μ, but the methods and instruments described could be used to 30μ with slight modifications. Molecular spectra in this region are caused by changes in the vibrational energy. The particular wave-lengths or frequencies of radiation which a molecule absorbs are determined by the masses of the atoms forming the molecule, the forces between the atoms, and their relative positions. For the simpler molecules it is thus possible to correlate completely the absorption bands in this region with the normal vibrations of the molecule considered as a dynamical

system. Such calculations are most useful when infra-red spectra are being used for purposes other than analysis.

The above facts can be re-stated in a form which indicates more explicitly what may be expected when using near infra-red spectra as the basis of analysis. In general the spectra of two molecules will be different when any of the three following conditions exist: (1) The molecules contain different atoms (methane and chloromethane). (2) The molecules contain the same atoms but the bonds between them are different (butane and butylene). (3) The molecules contain the same atoms held together by the same forces, but the atoms are in different relative positions (*n*-butane and *iso*-butane).

The paper discusses these points in some detail with typical illustrations.

A. H. N.

Analysis and Testing.

769. The Ultraviolet Absorption Spectra of Aromatic Hydrocarbons. R. N. Jones. *Chemical Reviews*, 1943, **32**, 1–46.—References to the absorption spectra of 370 aromatic hydrocarbons are given, and the influence of the structural factors on the absorption spectra are discussed. The spectrum of the benzene molecule is much more susceptible to the influence of substituents than that of the polynuclear aromatics. The individual effects of the introduction of alkyl, alicyclic, and aryl derivatives on the absorption spectrum of a given aromatic nucleus are discussed. J. W. H.

770. The Penetrometer Method for Determining the Flow Properties of High Viscosity Fluids. W. W. Pendleton. *J. Appl. Phys.*, April 1943, **14** (4), 170–180.—A review of the literature has shown that there was no reliable method of measuring the flow properties of fluids in the range of viscosity 10^6–10^{12} poises where the flow is "generally viscous." The theory of the penetrometer has been developed in this paper to a point where absolute viscosities may be determined both for viscous flow (viscosity independent of rate of shear) and generally viscous flow (viscosity dependent on rate of shear). The new penetrometer method was checked (1) with the capillary viscometer for viscous flow using coal tar pitch, and (2) with the revised axially moving cylinder method for generally viscous flow using a high melting blown asphalt. For any one temperature, the flow properties of a generally viscous material are defined by the straight line relationship between log shearing stress and log rate of shear. From this relationship viscosity may be calculated at any desired rate of shear. The slope of this line is required in the calculation of rate of shear both for the penetrometer method and for any other type of standard viscometer method. An independent means for observing was developed for the penetrometer and for the moving cylinder method. It is shown that earlier formulæ for standard instruments based on viscous flow are invalid when applied to fluids showing generally viscous flow properties. The power function law relating shearing stress and rate of shear has been found to hold for the asphalt studied over the range of rate of shear from 10^{-5} to 10 reciprocal seconds. In addition to speed of operation and precision, the penetrometer has the advantages of minimizing the elastic effects and reproducibility without extensive heat treatment and preworking. Entire shearing stress-rate of shear curves can be determined with one load and one penetration using a succession of time intervals. A. H. N.

Special Products.

771.* Peace-Time Values from a War Technology. G. Egloff. *J. Inst. Petrol.*, May 1943, **29** (233), 135–145. *Paper presented before War-Time Marketing Conference, American Management Association.*—The paper deals with a number of subjects varying from improvements in treating the wounded and consequent reduction in death-rate of combatants to synthetic rubber and plastics. A. H. N.

BOOK REVIEW.

Emulsions and Foams. By S. Berkman and G. Egloff. Pp. viii + 591. Reinhold Publishing Corp., New York, 1941.

Whilst the title of this book indicates a discussion of a generic nature, the authors quickly reveal—even in the preface—that it deals to a large extent more specifically with emulsions and foams of petroleum than those of other types. The book is divided into two main sections: (1) theoretical, and (2) practical knowledge of emulsions and foams. Theory is afforded 150 pages and practice 400 pages. This ratio of 1 : 2·6, however, is not truly representative; the theoretical section is a thorough and painstaking compilation of reports on practical laboratory experiments. The book is, indeed, a good summary of the practical knowledge about petroleum emulsions and foams. It is difficult to see how a theory of emulsions or foams or any other branch of colloidal science can be worked out in full with our present meagre knowledge of the liquid state. Until the theory of liquids is evolved and tested with a similar degree of success as has already attended the kinetic theory of gases, we cannot hope to have better knowledge than the findings of different laboratories. These findings are often contradictory, and sometimes inexplicable; the correlating fundamentals behind the findings are unknown. Hence, despite the great efforts the authors make in splitting the first chapter into two main sections on emulsions and foams, and further sub-divisions dealing with effects of different properties (*e.g.* surface tension, viscosity, etc.), in order to elucidate the fundamental nature and behaviour of emulsions and foams, yet pages sometimes follow pages in puzzling contradictions, paragraphs disprove statements established in previous paragraphs, and even sentences throw doubts on preceding sentences. This is not due to any fault of the authors; merely the present state of knowledge regarding "the cloudy science" of colloids is to a large extent fog-bound. Indeed, the authors clear the view, to a certain extent, by summarizing the results of these studies at the end of each section, indicating the most probable correlation between observed facts and theory. Thus Chapter I forms an exhaustive summary of laboratory research, sub-divided into separate compartments, and finally integrated by a shrewd summary. The section on emulsions is appended by 296 and on foams by seventy-three references to the literature.

Chapter I is probably the most important to the student of emulsions and foams, and hence one or two minor criticisms might be excused. The first is that the treatment is in certain respects elementary. Thus equations like those of Einstein, Stokes, Gibbs and others are given in their final—and sometimes the approximate—forms without a critical study of derivations and limitations. Viscosity is treated as a constant in systems where it changes with changing conditions of stress and strain. The second is that the data collected from the literature are reported in many cases too impartially. This results in apparent or real contradictions being reported with no guidance to the student except in the short summary at the end of the section as to which line he should follow. Again, certain results which have been doubted subsequent to their publications may be reported with a stronger sense of conviction than they deserve. It is, of course, understood that both these criticisms are matters of opinion rather than condemnatory facts, but they are given in the belief that the otherwise excellent Chapter I loses a little in value due to these shortcomings.

The other four chapters deal with the practical knowledge of emulsions. Chapters II and III discuss the practical, or industrial, processes of emulsification and demulsification respectively. The treatment is exhaustive, severely technological (the patent literature is very well represented), and almost entirely devoted to petroleum emulsions. The subjects are treated under the usual headings, but with great thoroughness—Chapter II has 443 and Chapter III 658 references to scientific and patent literature. The sub-division of the complex subject of demulsification into the various systems used shows much thought and is all that can be desired.

Chapter IV deals with two important branches of useful petroleum emulsions; the first section treats in some detail asphalt and bitumen emulsions; the second, lubricants and lubricating emulsions. In discussing a subject like asphalt and

bitumen emulsions in only half a chapter, instead of a whole volume, it is an extremely difficult problem to decide what to include and what to reject, and, having decided that, to determine how far each item can be studied. Yet the authors manage in 48 pages to give a concise and clear exposition of the main problems, criteria and tests connected with bituminous emulsions. The treatment is rather empirical, but most of our knowledge about the subject treated is empirical.

The preceding remarks apply equally well to the second section of the chapter, dealing with lubrication. In a very small space the authors manage to present a good picture of the multitudinous aspects of lubrication—oiliness is discussed in a single page with another page dealing with tests for oiliness—yet sufficient is said to indicate to the student the path along which he must tread. "The fact that the principles of adsorption at phase boundaries apply not only to emulsions but to lubricants indicates a parallelism between emulsification and lubrication." This is the introductory sentence to the study, and it partly explains why lubrication should be included in a book on emulsions and foams. It must be pointed out that the study is mainly confined to boundary lubrication when lubricants, other than emulsions, are discussed. Yet there is a feeling that a page here and there simply does not fit into the scheme of "emulsions and foams"—*e.g.*, studies on compressibility and tensile strengths of lubricating oils. Further, if lubrication is to be discussed because of the influence of surface phenomena on the matter, then surely greases should have been studied. On the whole, the reviewer is of the opinion that this section of Chapter IV could be rewritten with advantage by confining the studies strictly to emulsions in lubrication.

Whilst Chapters II, III and IV are probably the most important to the practising engineer, Chapters I and V must form the greatest interest to the research worker. Chapter V deals with the examination of emulsions. Important tests are discussed in sufficient detail—anyone who attempted to evaluate accurately the water content of heterogeneous systems containing hydrocarbons and soaps will agree that the apparently lengthy 11-page discussion of this subject is not at all too long. Similarly the tests for surface phenomena could, if any change were required, be a little more detailed. Electrical properties are well catered for too. Only viscosity has been treated rather arbitrarily. It is true that its effects on emulsion formation and stability and on foams is secondary, nevertheless the omission of any detailed reference to fundamental methods of measuring viscosity is probably a mistake. The U-tube viscometer is merely referred to, whilst rotating viscometers are not even mentioned. Space is given instead to illustrating the Saybolt, the Engler and the Redwood viscometers. Again, the "Appendix" to the chapter deals with subjects which are not connected with emulsions or foams: origin of petroleum and certain A.S.T.M. and I.P. Standard tests of petroleum, including such items as the carbon residue and sulphur determinations. As anyone who intends to perform these tests will naturally refer to the A.S.T.M. handbook or to "Standard Methods for Testing Petroleum and its Products" for details, it is felt that the pages used on illustrating these standard tests could be better used to describe the non-standard methods of measuring viscosity, surface and interfacial tensions in greater detail. Nevertheless, sampling and testing emulsions are truly well described and illustrated.

The volume is well bound, in a serviceable size, and extremely few errors could be detected. The most important of these is in the formulæ for dynamic surface tension, page 496. The book is heartily recommended.

ALFRED H. NISSAN.

BOOKS RECEIVED.

British Standard No. 1099 : 1943.—Small Fusion-Welded Steel Air Receivers. Pp. 21. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2*s.* net.

This specification forms part of a series of British Standards for Steel Air Receivers.

British Standard No. 1101 : 1943.—Pressure Paint Containers. Pp. 23. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2*s.* net.

This specification forms one of a series of British Standards for Pressure Vessels.

American Society for Testing Materials. Proceedings of the Forty-fifth Annual Meeting. Vol. XLII, 1942. Committee Reports and Technical Papers. Pp. 1217. American Society for Testing Materials, 260, South Broad Street, Philadelphia, Pa., U.S.A.

The Production Authorities Guide. Ministry of Production, June, 1943. Pp. 20. H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 4*d.* net.

This guide shows at a glance which is the Authority responsible for the production of manufactured products that are not obviously the concern of a single Government Department.

Institution of Chemical Engineers. Transactions. Vol. 19. 1941. Pp. 100. Institution of Chemical Engineers, 56, Victoria Street, London, S.W.1.

Iron and Steel Institute, Journal. Vol. 146, No. 2. 1942. Proceedings, 1P to 504P. Survey of Literature, 1A to 233A. Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1.

Among the sixteen papers presented at the Autumn Meeting of the Institute, the following may be mentioned as being of interest to the petroleum industry :

Tests on the Corrosion of Buried Ferrous Metals. (J. C. Hudson, T. A. Banfield, and H. A. Holden.)

A Study of some Soluble Inhibitors with Special Reference to Heat Transfer and Water Line Attack. (R. S. Thornhill and U. R. Evans.)

Journal of the Engineering Society, University College, University of London. Pp. 60. University College, London, at University College, Singleton Park, Swansea, South Wales.

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Geology and Development.

772.* Discovery Rate Continues Below Wartime Needs. L. J. Logan. *Oil Wkly*, 17.5.43, **109** (11), 9.—Excluding semi-wildcats and extensions, 218 wildcats were completed in U.S.A. in April 1943, 27 being productive. While optimistic estimates place the oil so discovered at 150,000,000 brl., conservative estimates give the figure as under 65,000,000 brl., about half the current rate of production. The rate of wildcat completions in 1943 has been only 2900 per year, compared with the P.A.W. goal of 4500.

Ninety-five oil and distillate fields have been found in the first four months of 1943, compared with 105 in the same period of 1942, while there were 18 new pay discoveries in the 1943 period, against 58 in the 1942 period.

In April, Michigan provided two small new fields, Indiana two extensions, Illinois one fair field, one extension and three new pays, Oklahoma four mediocre fields and two extensions. In April, as in March, a comparatively high proportion of the potential new oil discovered was on the Louisiana–Texas Gulf Coast, although East Texas had two discoveries which may develop into major fields. California had two new gas-field discoveries. Ellenburger production, probably of considerable importance, has been found in two tests in Winkler County, West Texas.

Tables show by States and districts the results of wildcatting in April and in the first four months of 1943, with some 1942 figures for comparison; and there is a list of the successful April wildcats giving the name, company and location, depth, producing formation, initial production, type of structure, and method of discovery.

G. D. H.

773.* Brazil's Sharp Production Rise Will Continue When Equipment Available. Anon. *Oil Wkly*, 24.5.43, **109** (12), 49.—Brazil's oil production was 2075 brl. in 1940, 3150 brl. in 1941, and 23,109 brl. in the first nine months of 1942, but on receipt of the necessary equipment it seems likely that the output from known fields will be at the rate of about 225,000 brl./year. The most important production is from the fields of Lobato, Joanes, Candeias, Aratu, and Itaparica in Bahia, near the State capital. The Aratu pool has a gas output estimated at 10,000,000 cu. ft./day. Despite difficulties in obtaining drilling equipment, field work is being continued in the Cruziero do Sul district of Acre in westernmost Brazil.

G. D. H.

774.* Canadian Tar-Sands May Yield Oil for War Use. Anon. *Oil Wkly*, 24.5.43, **109** (12), 49.—If favourable results are obtained in the work planned for developing the Athabasca tar-sands this source may provide 10,000 brl. of oil/day.

Much of the sands area is overlain with heavy overburden or lean sands. At present the sands are lightly blasted, excavated by power shovel and transported to the recovery plant by truck. Increased heat conservation seems necessary in the recovery process, for during a test period over 40% of the oil production was used for plant fuel.

G. D. H.

775.* New Zealand Oil Activities Halted. Anon. *Oil Wkly*, 24.5.43, **109** (12), 49.—Four dry holes have been drilled by the Superior Oil Co. in New Zealand to depths ranging 2985–7100 ft. Two wells were in the central part of the North Island, and two on the west coast of the South Island.

G. D. H.

776.* Mental Attitude Important Oil-Discovery Factor. Anon. *Oil Wkly*, 31.5.43, **109** (13), 9.—Reflection on the petroleum discovery and producing records of the United

States as compared with those of other countries arouses suspicion that physical conditions in the earth's crust impose fewer and less formidable obstacles to the development of commercial oil-fields over the earth than some mental and social habits. Until the earth at large has been explored to the same extent as the United States, oil will remain undiscovered, no matter how plentiful it may be. U.S.A. constitutes 5% of the total land area of the earth, contains 11% of the total marine rocks of the earth, and only 15% of the earth's total area of important marine rock-filled sedimentary basins of a character favourable to the occurrence of oil-fields; yet U.S.A. has furnished 54% of the total oil discovered to date. Per unit area U.S.A. has found twenty times as much oil as has been found in the rest of the world, and per unit of favourable area seven times as much as in the rest of the world. There is little evidence to support a conclusion that U.S.A. has seven times as much oil as the rest of the world, but there is abundant evidence that Americans have searched more assiduously for oil and find oil more effectively than any other people. Americans have found much of the oil in countries outside their own.

Oil exploration in U.S.A. is carried on freely and continuously by thousands of independent enterprises which drill year by year 20,000 or 30,000 test-wells at no expense to the Government. Inspired by the financial reward that comes of success, wells are drilled in any unexplored territory, whether the experts think well or badly of its promise.

Over a million wells have been drilled in U.S.A., more than 200,000 being exploratory dry holes. U.S.A. has drilled one exploratory test for each 12 sq. ml. of sediments, whereas in the rest of the world the figure is one for each 1100 sq. ml.

At the current rate of consumption the probable ultimate oil resources of the earth should last for 300 years, although present proved reserves are hardly equal to 20 years' supply.

From time to time the U.S. Government has shown an interest in oil reserves outside U.S.A., and urged exploration in Mexico and South America, as well as securing U.S. participation in Irak.

The American wildcatter would find attractive territory in many European countries, and intensive oil search is required in the Near and Far East and South America, in addition to U.S.A. itself. G. D. H.

777.* Wildcat Promises New Field for Colombia Near Coast. Anon. *Oil Wkly*, 31.5.43, **109** (13), 40.—El Dificil No. 1 promises to open a new field in Colombia. It was drilled to 5930 ft. on a major structure, and is credited with flowing 130 brl./day of 46-gravity oil through a $\frac{1}{4}$-in. choke from a 600-ft. section of porous limestone. A pipe-line to the coast from this area would be short and across relatively easy terrain.

Twenty ml. south-east of El Dificil is another wildcat, Brillante No. 1. G. D. H.

778.* Inspection and Analysis of Formation Samples. L. C. Uren. *Petrol. Engr*, June 1943, **14** (9), 51.—In determining the porosity of a rock sample, the bulk volume of the sample may be determined (*a*) by immerson in a liquid which does not enter the pores, and measurement of the volume of liquid displaced; (*b*) by saturation with a fluid and then measuring the amount of liquid displaced on immersion; (*c*) by coating the specimen with a water-impervious substance, with subsequent weighing in air and water; (*d*) by dressing to some simple geometrical form the dimensions of which are measured; (*e*) by finding the density of the mineral forming the specimen, and also the pore volume, which, together with the specimen's weight, enable the bulk volume to be found.

The pore volume can be found by finding the bulk volume and the volume of the mineral substance and subtracting. The volume of the mineral substance may be found (1) by gas displacement; (2) by finding the weight of liquid needed to fill the pores; (3) by weighing the dry specimen, saturating it with a liquid and then re-weighing in the same liquid; (4) by crushing the specimen to separate the grains which are then placed in a pycnometer for volume measurement.

In order to find the size distribution of the grains in the sample, the grains must be separated. Some rocks crumble readily, while others must be disaggregated by heating and rapid cooling, by freezing liquid in the pores or by dissolving the cement. Before screening, oil must be dissolved from the grains. The size distribution is found by

sieving, and by elutriation for the grains passing 200-mesh. The results are generally displayed graphically. G. D. H.

779. Classification of Sedimentary Rocks Related to Kind of Oil Reservoir. W. V. Howard. *Oil Gas J.*, 3.6.43, **42** (4), 70.—From the standpoint of correlation of beds, a classification based on the obvious physical characteristics of sediments may be adequate, provided that it is based on standardized descriptive terms. But if it is required to use the knowledge for the location, development, and production of oil-fields, other types of classification are necessary. A genetic classification is needed. The material deposited in any environment depends on conditions within the environment and also on conditions in the area from which material is transported into that environment. Van der Gracht and Krynine have suggested classifications on this basis. The former considers not only the normal sediments of shallow seas bordering coastal plains areas, but also "flysch" deposits laid down in a geosyncline directly previous to the major elevation of the neighbouring land. The basin of deposition may range from shallow to deep, and the environment from marine to continental. The sediments tend to range from fine clastics below to coarse clastics above. Krynine's preliminary classification refers to sandstones, and subdivides these into "clean" (formed after long decay in peneplained areas or by re-working of previously deposited quartzose sediments), "greywackes" (with much slate, shale, chert, and micas and other relatively unstable minerals indicating fairly rapid derivation from an uplifted land mass worn down to the level at which mildly metamorphosed rocks occur), and "arkoses" (felspathic sandstones). As the mountains are worn down further, erosion and deposition are less rapid and chemical action becomes more important, resulting in the formation of such materials as granite wash.

However, the nature of the terrane uplifted has as much to do with the sediments deposited as the amount of uplift.

Normal (quartzose) sediments are derived from relatively flat-lying land masses on which erosion is slow and chemical decay intense. They tend to be uniform in texture and composition over long distances, the sandstones being clean, and as blanket deposits they produce on structure. Wedge-edges are rare. Limestones and dolomites make up much of the section, and may have been uplifted, and eroded over wide areas. The shales are largely clay shales. The clean, uniform sands may be expected to give high primary oil recoveries except with dissolved-gas drive.

The flysch sediments arise from relatively rapid denudation of an uplifted land area, with deposition in a geosyncline. Depending on the relative rates of deposition and sinking of the geosyncline, the beds will be a mixture of marine and continental deposits, often associated with coal. Rapid variation in short distances is common, with numerous wedge-edges, lenses, sand bars, and other forms of stratigraphic trap. The sands tend to be dirty. Limestones are rare, thin, and of little extent. Correlation is difficult. Production on structure is frequent, but stratigraphic traps are commoner than in the normal type sediment. Irregularities of porosity and permeability, with limited extent of the reservoirs, make water- and gas-cap drive less likely.

Molasse sediments will be arkosic if the mountains have been denuded to the granite. They result from rapid erosion of steep slopes, and are deposited mainly in foredeeps. They are poorly sorted and poorly weathered. As the basin fills they tend to get finer, and may go from marine to continental. Limestones are generally absent. Flysch and molasse deposits are not sharply separated. Stratigraphic traps are common in molasse, even of continental origin. Their irregular permeability prevents high recoveries.

Often the later molasse sediments are continental, but at times they remain marine and grade into the normal type. Sometimes they include beds of granite wash (highly weathered arkose), and limestones and dolomites may be interfingered with this. The latter point to dominance of chemical over mechanical erosion. G. D. H.

780.* Colombian Development Prospects Have Improved Materially During Year. Anon. *Oil Wkly*, 7.6.43, **110** (1), 47.—The Shell has drilled ten producing wells in the Casabe field which was discovered last year. Two sands have been proved, and the reserves are estimated at over 135,000,000 brl. Production has been found more

recently in the Dificil field of the Departmenta Magdalena. This production, which comes from a porous limestone at 5928 ft., is Colombia's most northerly oil-field.

Two new structures have been found on the Barco concession. G. D. H.

781.* Mexico Reports Discovery of New Producing Horizon. Anon. *Oil Wkly*, 7.6.43, **110** (1), 47.—A new producing horizon is reported in the area around Minatitlan, Vera Cruz. This discovery well is in the north-west corner of the field and is giving 2800 brl./day.

In the Poza Rica field two good wells have been completed recently. One flowed initially at 3000 brl./day from 2385 m., and the other at 3500 brl./day from 2990 m. G. D. H.

782.* To Drill Canadian Wildcat 65 ml. East of Edmonton. Anon. *Oil Wkly*, 7.6.43, **110** (1), 47.—Preparations are being made for drilling midway between Bruce and Holden, Alberta. The area, which is 18 ml. west of the Viking and Kinsella fields, has good surface indications of oil. G. D. H.

783.* To Drill Costly Wildcat in Canadian Waters. Anon. *Oil Wkly*, 7.6.43, **110** (1), 47.—A 12,000-ft. test is to be drilled in Hillsborough Bay adjoining Northumberland Strait. The test is on a large structure mapped at the surface and confirmed by seismograph, and lies under a mile south-west of a well taken to 5965 ft. without finding signs of oil.

Seepages have long been known in this part of Canada, and near Moncton, New Brunswick, is a small field yielding mainly gas. G. D. H.

784. Importance of West Texas Ordovician in National Picture Still Not Clear. H. F. Simons. *Oil Gas J.*, 10.6.43, **42** (5), 30.—Ordovician developments in West Texas show that the formation is important, but there is not yet sufficient information to determine fully the formation's potentialities. Where Ordovician oil has been found beneath Permian fields the trap has been anticlinal. The Permian structure has been a rather broad and gentle anticline, a type which is common. However, some Permian structures are small and steep, and there is considerable Permian production from reef and stratigraphic traps, but in these cases no deep tests have been made. The Ordovician structures have been found to be much sharper than the Permian structures, and therefore the extent of the Ordovician reservoirs is likely to be less than that of the Permian pools. It is possible that there may be Ordovician production below Permian features which lack adequate closure.

The seismograph will probably be used more widely in the future in finding Ordovician structures. The Ellenburger seems to be reasonably uniform, the pools generally having gas-caps and probably an effective water-drive, with a pay thickness of 80–150 ft.

Other Ordovician pays may have possibilities as well as pays below the San Andres and above the Ellenburger, for practically all the Ellenburger wells have shown possible production in the upper formations.

10,000-ft. West Texas wells have cost about $350,000, but the cost will probably be reduced to $150,000 and eventually much less. G. D. H.

785. Oil Zones of the United States : Pennsylvanian. Anon. *Oil Gas J.*, 10.6.43, **42** (5), 64-C.—In the Alleghany Plateau region, Pennsylvanian production is largely limited to the central part of the basin, the most important sands being the Little Dunkard and Big Dunkard of the Conemaugh, the Burning Springs sand of the Alleghany, and the Second Cow Run and Salt sands of the Pottsville. There are interbedded gas-sands. The chief Pennsylvanian production of the Illinois basin is at the southern end of the La Salle anticline (Siggins, Casey, Claypool, Upper Partlow, Bridgeport, Biehl, and Buchanan sands). In the Centralia area, on the Du Quoin anticline, the Petro sand is productive. The principal Pennsylvanian production in Indiana is from the Mansfield sand of Pottsville age. Much of the earlier production is Eastern Kansas, North-east Oklahoma, and the McAlester basin, extending across the Hunton and Chautauqua arches and the buried Nemaha ridge, came from a series of

Pennsylvanian sands, the age of which increases to the south (Stalnaker, Layton, Peru, Prue, Bartlesville, Burgess, Burbank, Hoover, Calvin, Gilcrease, Papoose, Cromwell, Lyons, and Dutcher). On the Central Kansas uplift there is important Kansas City-Lansing lime production. On the Bend Arch also the age of the Pennsylvanian producing horizons increases to the south. In Eastern Wyoming the Minnelusa is productive, and the extensive Tensleep sand in Central and Western Wyoming.

Additional Pennsylvanian production may be found in the basins flanking the Bend Arch, and Minnelusa production may extend down the east side of the Denver basin, some small pools already having been found in Western Kansas. Tensleep production is possible round most of the Rocky Mountain basins. The Salina basin of Eastern Kansas may contain Pennsylvanian oil.

Most of the Pennsylvanian sand production is near uplifts associated with the Appalachian folding, for at its peak in Pennsylvanian times the uplifts of the Appalachians, Ouachitas, Ozarks, Arbuckle, Wichitas, etc., were subjected to strong erosion. The low areas sank, giving a thick series of alternating clays and sands with some limestone. Sometimes the basinal sediments were uplifted, and when limestones were exposed they frequently acquired sufficient porosity to become reservoir rocks. G. D. H.

786.* Well Drilling Decline Continues in May. Anon. *Oil Wkly*, 14.6.43, **110** (2), 57.—The average weekly rate of well completions in May was 339, compared with 355 per week in April. During the first five months of 1943 7263 wells have been completed, against 9204 in the corresponding period of 1942. Relaxation of drilling regulations has caused California to drill 615 wells in the first five months of 1943, whereas only 315 were completed in the first five months of 1942; in Kentucky the corresponding figures were 115 and 57 respectively. Activity in Texas is greater than in any other State, and both completions and rigs in operation are scarcely more than 50% of the 1942 figures.

Completion data are tabulated by States and districts for May and for the first five months of 1943, with some 1942 figures for comparison. G. D. H.

787.* Intensive Development of Oil-fields Has Increased Petroleum Output of Peru. Anon., *Oil Wkly*, 14.6.43, **110** (2), 59.—The downward trend of oil output in Peru has been stopped, but there are no signs of a sharp increase in production. In 1936 17,593,000 brl. of oil were produced, an all-time peak, 11,922,000 brl. in 1941, and 13,500,000 brl. in 1942. Exploration and leasing have been very restricted in the past year, due to tax increases and refusal of applications for concessions.

The Ganzo Azul field of Eastern Peru, opened in 1939, is now producing more oil than is required in the surrounding district, and marketing of oil in Brazil and Uruguay is being planned. The oil is in the Lower Cretaceous on an anticline which is 16 ml. long, 7 ml. wide, and has 3500 ft. of closure.

In North-west Peru, La Brea–Parinas produces from the Eocene at depths of 60–6000 ft. on a faulted, folded structure. The output from 1750 wells spread over 13,500 acres is 25,000 brl./acre. The cumulative production exceeds 225,000,000 brl. The Lobitos field is geologically similar to La Brea–Parinas. It covers 2000 acres, and has an output of 7000 brl./day from depths of 3000–6000 ft. The cumulative production is about 55,000,000 brl. The 50-year-old Zorritos field now produces from a few wells only. The oil is in faulted Miocene sands at depths of 300–1700 ft. The productive area is about 400 acres, but not fully defined.

Peru has one large refinery and two small skimming plants. Oil is Peru's principal industrial fuel; it is also used on the railways, and some is exported.

A table gives the oil production and consumption figures for recent years.

G. D. H.

788. Lithification Processes and Early Oil Formation in Sediments. W. V. Howard. *Oil Gas J.*, 17.6.43, **42** (6), 92.—Cementation or lithification depends on two main factors: the composition of the water in which the sediments are deposited, and the rate of deposition. Calcium carbonate, the commonest cement, is carried in solution as the bicarbonate. It is probable that much of the annual increment of calcium and carbonate reaching the sea is precipitated, as the sea is nearly saturated with calcium

carbonate. That part of the calcium carbonate secreted by animals as shells and skeletons eventually reaches the sea-floor, where there is continual solution and reprecipitation of this material, with the result that the openings between grains of clastic material become filled or partly filled with calcite. This tends to cement the grains together.

Actually deposition of calcium carbonate takes place almost everywhere in the sea, and limestone is formed where there are no other sediments deposited with it. Hence the greater proportion of limestone in normal than in flysch sediments and their almost complete absence in molasses.

Cementation is not a question of age, but rather of conditions of deposition, and the comparatively recent history of the earth is probably such as to make the study of recent sediments insufficient to show all that should be known about older sediments.

Trask found an average of 1·6% of organic matter in recent sediments, and if five-eighths of this becomes oil this would be 3 gal./14 cu. ft. of sediment, or about 222 brl./acre-ft. Hence a drainage area three or four times the size of an oil-pool would provide *in situ* origin of oil without migration from other beds and without much migration along the reservoir bed.

The Gaspar limestone of Northern Alabama has oolites with calcite core, a ring of bitumen, and then more calcite, pointing to bitumen deposition when the limestone was being formed. The Anacacho limestone of Uvalde County, Texas, is simply a limestone "sand" cemented by asphalt, and treatment with carbon tetrachloride leaves a heap of loose limestone grains. G. D. H.

789. Post-War Demand for U.S. Crude. W. V. Howard. *Oil Gas J.*, 24.6.43, **42** (7), 78.—It is reasonable to assume that the post-war crude demand will continue to increase at the pre-war rate—*i.e.*, by about 60,000,000 brl./year, giving a total of 1,700,000,000 brl. in 1947.

The discovery rate has been falling for nearly five years, and even if last year's discoveries are allotted their probable recovery rather than their estimated proven reserves, they are still 45% below the output.

Based on existing conditions, the trend of discovery, and the present transportation system, it is probable that the 1943 demands can be met, but that 1944 production will be about 40,000,000 brl. below estimated demand. The peak of production from existing fields, together with additions at a rate comparable to that provided by new fields during the past four years, will probably be reached in 1944, followed by a decline to about 1,350,000,000 brl. by 1947. Texas will probably reach its peak in 1945, when its output will have risen by 100,000 brl./day. California, Louisiana, Kansas, and Arkansas are likely to reach their peak this year.

In the past two years about 24,000 wells have been abandoned, and this calls for the drilling of at least 15,000 producers per year, and preferably about 20,000. If these numbers are not attained, then drilling immediately after the war will have to be at an even higher rate, perhaps 30,000–35,000 per year.

While secondary recovery methods increase the production of individual fields, their effect is relatively small when considered on a national basis. A growing shortage, probably accompanied by higher prices, encourages the use of these methods. If sufficient wells cannot be drilled in U.S.A., then additional oil supplies will have to be drawn from South America and Mexico.

When the liquid oil supply fails to meet demands, resort must be made to the extensive oil-shale deposits, the tar-sands of Canada, and the low-grade coals, all of which will yield oil at a price.

A graph shows the production of the major U.S. oil-producing States from 1935 onwards, with extrapolation to 1947. The peak year for each State is shown, and the possible deficiency in 1947 is indicated. G. D. H.

790. Derivation of Reservoir Rocks. Part I. W. V. Howard. *Oil Gas J.*, 24.6.43, **42** (7), 158.—Oil has been found in weathered granite and the Madison limestone of Montana, Wyoming, and Alberta. The sequence of events was probably: (1) formation of rock which later became reservoir; (2) exposure to erosion; (3) development of porosity; (4) burial beneath sea; (5) entrance of oil-forming material and deposition of sealing formation. This sequence was probably followed in reservoirs responsible for more than half of the world's production of oil.

The cycles of uplift and sedimentation are generally oscillatory, and sediments of

the normal type start and conclude each complete cycle, and may be interbedded in sections predominantly of the greywacke or arkose classes. All the processes which lead to the formation of oil reservoirs are involved in the areas which yield sediments of the normal type and in the areas in which they are deposited. These processes are, however, modified in deposits of the flysch and molasse type.

The breakdown of sandstone or conglomerate by removal of the cement and changes in the constituent fragments gives reservoirs of four types: (1) The sea may advance over a partly eroded sandstone or conglomerate before disintegration is complete, thus creating truncated sand reservoirs beneath an unconformity. It will have widespread permeability. (2) Much disintegrated sandstone and conglomerate form sands and gravels in rivers and lakes. Advancing sea may not remove these deposits generally, and the buried river deposits form reservoirs of the shoestring type. (3) Unconsolidated rock mantle may be picked up and redistributed by an advancing sea as numerous sand lenses overlapping shoreward. They tend to lie on old land surfaces, and may have impermeable streaks and constitute near-shore sand bodies and buried sand-bar reservoirs. (4) Blanket-type sands are said by some to be re-worked material deposited by sea advancing over land, the fine material having been largely removed, whereas others maintain that the sand is carried to the sea and deposited. Conglomerates are generally believed to be basal, formed by sea advancing over a pebble- and sand-strewn land mass.

In decomposition the cement and accessory minerals of sandstones are added to the list of products derived from sandstones. G. D. H.

791. Rigs and Drilling Wells Increase in May. Anon. *Oil Gas J.*, 24.6.43, **42** (7), 190.—The 1358 wells completed in U.S.A. in May 1943 were seven more than in April, but forty-seven fewer oil-wells were brought in. 499 wells were dry. For the third consecutive month the number of wells in the 5000–10,000-ft. class showed an increase. So far this year total completions are 4·4% below the 1942 figure, and the number of oil-wells is 14·9% below the 1942 level.

A table gives by States the number of completions, oil- and gas-wells, the footage, number of active rigs, and the number of wells in various depth ranges.

G. D. H.

792. Oil Zones of the United States: Permian. Anon. *Oil Gas J.*, 1.7.43, **42** (8), 48-C.—Permian oil production in U.S.A. is confined to three areas, of which the Permian basin of Texas and New Mexico, and the Amarillo–Hugoton area are the most important. The producing limestones and associated clastics become progressively younger from north to south, limestones, dolomites, and granite wash of Wichita–Albany age being productive in the Panhandle area. In the central part of the basin the San Andres limestone is the principal oil horizon. Still farther south and west, the Whitehorse group yields most of the oil. On the west flank of the Fort Stockton high, the Delaware sand (equivalent to the Lower part of the San Andres) is highly productive. In the last stages of infilling of the marine basin, the producing sands of the Red River district were formed; this is continuous with Permian production in the Anadarko basin.

In Wyoming, especially round the margin of the Big Horn basin, the Embar yields important quantities of black oil.

Most of the Permian deposits in other parts of U.S.A. are continental, thereby precluding oil production, but considerable extensions of known producing belts is possible.

Many of the West Texas fields have only been drilled into the top of the Permian, and the area between West Texas and the Panhandle field has been little prospected. There are possibilities of Permian oil in Southern Oklahoma, both north and south of the Wichita–Arbuckle mountain belt. Western Wyoming may provide Permian oil in several of its basins.

The Permian represents the last marine deposits of the Midcontinent area, so that no production can be expected above it north of the Ouachita–Mexia–Balcones belt, but this does not include the Rocky Mountain area where basins did not form until long after the Permian. G. D. H.

793. Mexican Production Rising. Anon. *Oil Gas J.*, 8.7.43, **42** (9), 17.—The Petroleos Mexicanos oil production fell from 136,843 brl./day in January 1942 to 67,820

brl./day in November, but rose to 88,465 brl./day in April 1943. Poza Rica is the most prolific area under Pemex Management, and current production averages about 57,500 brl./day.

Independent companies normally produce 4000–4580 brl./day. G. D. H.

794. Completions Rise Sharply in California Heavy Fields. L. P. Stockman. *Oil Gas J.*, 8.7.43, **42** (9), 18.—It seems likely that 1500 new wells will be drilled in California during 1943. This figure is above the past yearly average, but the footage will be below the average figure because much of the projected development is in fields with pays at 1000–3000 ft. Portable units are being used extensively in this drilling campaign. The amount of drilling carried out during the first half of 1943 was about twice that for the corresponding period of 1942.

At South Belridge, where production is found at 700–1300 ft., wells are completed in about a week. There is increased drilling activity at Midway-Sunset, Elk Hills, Round Mountain, Newhall Potrero, Brea Olinda, and Huntingdon Beach. Much of the current development consists of drilling undeveloped acreage in the older fields, such as Buena Vista Hills, Coalinga, Midway-Sunset, Mount Poso, Round Mountain, Santa Maria Valley, Huntingdon Beach, Torrance, Elk Hills, Ventura Avenue, Newhall Potrero, East and West Coyote, and Montebello. Wildcatting has not been especially successful. Thirty-five new wells are expected to be drilled at Elk Hills, where much extension work remains to be done. Miocene production was discovered there a year ago, and although the sand is fairly tight, there are indications of a large reserve.

Californian crude-oil production seems to have reached its present peak because of the application of the maximum-efficiency-rate factor, and the necessity of reducing high gas/oil ratio wells in order to eliminate gas waste. G. D. H.

795. Porosity Limit with Depth. H. W. Bell (with discussion by W. V. Howard). *Oil Gas J.*, 8.7.43, **42** (9), 66.—At some depth, the plasticity of the rocks due to temperature and pressure will become such as to eliminate porosity, and so prevent the obtaining of any fluid. The fluid in pores will resist compressional collapse of the pores. If the maximum compressive strength of the rock material is 10,000 lb./in.², then if the effective collapsing force is 0·692 lb./in.²/ft. the porosity will vanish at about 14,500 ft. Gutenberg's data suggest that the limiting depth will be 21,000 ft. at 60° F., but considerably less at 400° F.

It is possible that some reservoirs have lost their porosity at 14,000 ft., but others may have reasonable porosity at 80,000 ft. During geological time it is possible that failure of a reservoir could take place at a pressure between the elastic limit and the ultimate compressive strength. Before the porosity disappears the oil may go into the gaseous phase and reach a higher density than its liquid, and as the porosity vanishes it may be driven into the pores of surrounding shales, probably ultimately entering into chemical combination with them.

Discussion. When a reservoir rock with its fluids is surrounded by impervious beds, the lack of avenues for fluid escape means that the depth at which the pores collapse will be very great. This is modified by the tendency for silica to be dissolved from small grains and at points highly stressed, with subsequent deposition around the larger grains at less-stressed points.

Cores from sands which have been deeply buried by amounts which can readily be estimated provide rock sections in which the amount of re-deposited silica can be observed. Incipient rupture of quartz grains is shown by strain shadows. If these shadows extend beyond the original grain into the re-deposited silica they indicate that the reservoir has begun to show signs of collapse. Sections can also be cut from sediments, now exposed, which have been buried extremely deeply. G. D. H.

Drilling.

796. Protection of Surface Hole in Lindsborg, Kansas, Wells. N. Williams. *Oil Gas J.*, 29.4.43, **41** (51), 45–47.—Certain problems, unusual in Kansas generally, but met in one field, are described. The principal trouble has been occasioned by porous, aqueous gravel beds, if not cavity sections, in the surface formations that result in loss of returns

of drilling fluid. Close to the surface there is a water-saturated loose sand or gravel bed which washes into the hole and causes caving unless protected. Although the condition is not universal over the field, it is sufficiently prevalent to offer a threat to all drilling. Special practices and precautions have had to be adopted in drilling and casing these formations to ensure adequate protection.

These conditions usually call for the running of two strings of surface casing as against one in normal Kansas operations. The first of these is required to protect the shallow fresh-water sands. Field regulations specify that a minimum of 175 ft. of pipe be set and cemented to the top. Operators usually find a good seat for this string at 185–190 ft. Cementing of both strings is discussed.

On one occasion, the operator, unable to cement off the formation by various other methods, resorted to drilling a second hole behind the pipe. First, several hundred sacks of cement were pumped in the usual manner without getting circulation. Then an attempt was made without success to seal the formation by squeezing cement behind the pipe through perforations just above the gravel bed. Attempts to run in cement behind the pipe through a 1-in. pipe in the annular space also failed. It was then decided to try drilling another hole through which additional sealing material could be pumped into the formation. For this the rotary table was skidded a few inches, just enough to permit clearly the 8¼-in. casing. A 6-in. bit was used, and the hole followed the back side of the pipe down to the top of the formation. First, quantities of cotton-seed hulls and heavy mud were pumped. Next large quantities of burlap were pushed down. Successive batches of burlap and heavy mud were forced into the hole, and by raising and lowering the pipe this was tamped and worked down around the back of the casing above the bed. Finally, after a number of days, a seal was effected and the hole was filled with cement.

The casing programme and other details are given briefly. A. H. N.

797.* Unitized Skid Transports Entire Rig-Lifting Setup. Anon. *Oil Wkly*, 3.5.43, **109** (9), 15–16.—This short note describes a unitized skid which was designed to provide adequate protection against haulage accidents and to effect saving in time and physical effort. A. H. N.

798. Direct-Current Rigs for Deep-Drilling Operations. R. A. J. Dawson. *Oil Gas J.*, 6.5.43, **41** (52), 129. *Paper Presented before American Petroleum Institute.*—Comparative cost and engineering-design studies are made and given in some detail. The general conclusions are: Large electric rigs must definitely be tailor-made of the very best of available equipment, but they fit very well into drilling programmes of certain types. There is no question of the many unique advantages of electric power in the drilling of deep, remote wildcats, and it is hoped that the oil industry will become increasingly cognizant of this economic oversight. An investment of approximately 250,000 dollars is admittedly a large sum, but such steady savings in operation costs are possible on the deep penetrations of to-day that the 50,000 dollars difference between the price of electrical and steam equipment can soon be overcome.

The future of electric drilling depends on the manufacturers' ability to prove the economy and flexibility of electric power, and to do this they must develop technical personnel that is familiar with actual drilling procedure. Development of such personnel will take time, but only by such a procedure will the oil industry capitalize on those flexible designs that are directly related to future economical operation.

A. H. N.

799. Well Logging. M. E. Kelly. *Fuel*, 1943, **22**, 55.—A short review is given of the basic principles of electrical, gamma-ray, and neutron logging. J. W. H.

800. Patents on Drilling. A. L. Parker. U.S.P. 2,316,806, 20.4.43. Appl. 14.3.41. Tube coupling.

H. G. Doll. U.S.P. 2,316,942, 20.4.43. Appl. 27.12.37. Apparatus for measuring temperature in bore-holes.

G. Miller. U.S.P. 2,316,967, 20.4.43. Appl. 24.6.41. Oil-base drilling fluid and method of regenerating the same.

G. Miller. U.S.P. 2,316,968, 20.4.43. Appl. 22.8.41. Oil-base drilling fluid containing air-blown asphalt.

W. F. Wingard. U.S.P. 2,317,010, 20.4.43. Appl. 25.7.40. Bore-hole deflecting tool in combination with a rotatable drill-bit.

A. S. Volpin. U.S.P. 2,317,122, 20.4.43. Appl. 11.6.42. Pump piston with flexible periphery.

H. G. Doll. U.S.P. 2,317,259, 20.4.43. Appl. 15.2.38. Device for determining the strata traversed by drill-holes.

C. Schlumberger and A. M. L. Doll. U.S.P. 2,317,304, 20.4.43. Appl. 11.5.35. Apparatus for electrical surveying of bore-holes.

J. E. Smith. U.S.P. 2,317,306, 20.4.43. Appl. 22.6.40. Rotary drilling rig for bore-holes.

G. L. Kothney. U.S.P. 2,317,386, 27.4.43. Appl. 14.3.42. Well-surveying instrument using electric current.

E. W. Rearwin. U.S.P. 2,317,404, 27.4.43. Appl. 16.11.40. Casing-head for a well through which a tubing may extend into the well.

C. A. Crowley and J. B. Mullen. U.S.P. 2,317,521, 27.4.43. Appl. 22.10.41. Sensitizer containing gel-forming colloidal clay.

T. B. Losey. U.S.P. 2,317,544, 27.4.43. Appl. 26.10.42. Coring-tool for side-wall coring.

L. C. Miller. U.S.P. 2,317,632, 27.4.43. Appl. 20.7.39. Means for surveying well-bores for inclination.

R. B. Booth. U.S.P. 2,318,284, 4.5.43. Appl. 27.3.41. Drilling mud containing migraine for viscosity control.

W. M. Burch. U.S.P. 2,318,370, 4.5.43. Appl. 6.12.40. Oil-well drilling-bit for rotary systems.

G. L. Kothney. U.S.P. 2,318,612, 11.5.43. Appl. 29.6.40. Well-surveying device with electric timing means.

D. G. Miller. U.S.P. 2,318,878, 11.5.43. Appl. 3.2.41. Open-hole tool-joint protector.

G. E. Nevill and A. L. Leman. U.S.P. 2,318,882, 11.5.43. Appl. 18.12.41. Ram construction for blowout preventers.

F. N. Osman. U.S.P. 2,318,885, 11.5.43. Appl. 18.12.41. Retriever shaped to be lowered into a well. A. H. N.

Production.

801. Calculation of Load and Stroke in Oil-Well Pump Rods. B. F. Langer and E. H. Lamberger. *J. appl. Mech.*, March 1943, **10** (1), A1–A12.—The sucker-rod pump as used in oil-wells is treated as a problem in the longitudinal vibration of bars. Solutions are obtained for the forces and motions at both ends of the rod-string, thus giving formulæ for the calculation of polished-rod load and plunger travel. The results of the calculations are compared with test results. The conclusions may be summarized.

Peak polished-rod loads and effective plunger strokes in an oil-well can be calculated by using the following formulæ:

1. Complete formula for peak polished-rod loads:

$$PPRL = W_R\left[1 + \frac{ESK_1}{288L^2\delta_c}\right] + W_0\left[\frac{E_0\omega S_P}{144A_0L\delta_0}\right] + 2W_{OD} - W_{RB}.$$

2. Field formula for peak polished-rod load:

$$PPRL = W_R - W_{RB} + W_{OD} + 0{\cdot}75SN[17A_R \tan(0{\cdot}0004LN)^\circ + A_0].$$

3. Complete formula for effective plunger stroke :

$$EPS = \frac{S}{R} - \frac{24LW_{OD}}{E}\left[\frac{1}{A_R} + \frac{1}{A_T}\right].$$

4. Field formula for effective plunger stroke :

$$EPS = \frac{S}{\cos(0{\cdot}0004LN)^{\circ}} - \frac{W_{OD}L}{2(10^6)}\left[\frac{1}{A_R} + \frac{1}{A_T}\right].$$

The strokes and areas are expressed in inches; forces and weights in pounds; the well depth L in feet; and the pumping speed N in strokes/minute. These dimensions are commonly used in the oil-fields. Values of K_1 and of $1/R$ are given in graphs in the paper. W_R = weight of rod-string. E = Young's modulus of rod material. S = polished-rod stroke. δ_e = effective density of rod material = density corrected for weight of couplings, etc. W_0 = weight of full height of fluid column on net area of plunger. E_0 = Young's modulus of fluid column. ω = angular velocity of crank, rad./sec. S_P = plunger stroke. A_0 = velocity of sound in fluid. δ_0 = weight of fluid/unit volume. W_{OD} = differential fluid load = change in plunger force at end of stroke = load due to net fluid head on full area of plunger. W_{RB} = buoyant force on rods. A_R = area of rod cross-section. R = factor for calculating plunger travel, and A_T = area of cross-section of tubing wall.

The results calculated by the foregoing formulæ agree closely with test values obtained from a comprehensive test programme, carefully carried out on a single well. It is believed that data determined by tests made with similar care on wells at other depths, or under other operating conditions, will also closely agree with calculated values. Such comparisons are invited. A. H. N.

802. The Relationship Between Reynolds' Number and Velocity Distribution. L. S. Rhodes. *J. appl. Mech.*, March 1943, **10** (1), A21–A22.—It is shown that, for turbulent flow, the velocity distribution in the cross-section of a pipe, and the ratio of the mean velocity to centre velocity, depend on the rate of variation of the friction factor with Reynolds' number. The treatment is mathematical. A. H. N.

803.* Midcontinent Reconditioning Practices Entering New Era. Part 2. L. E. Elkins, R. H. Smith, L. F. Peterson, and P. P. Manion, Jr. *Oil Wkly*, 12.4.43, **109** (6), 18.—In this part of the paper the authors discuss the extension of both the vertical and lateral drainage areas of wells in order to increase their production. Horizontal extension by acidizing is studied in particular detail. The real acidizing problem in any treatment, and especially in reconditioning wells, is to determine in what part of the section the acid should go, and then to control it so that it will go there. If acid is merely pumped into a well, and especially one penetrating a section substantially depleted, it will enter the most permeable section, which is also the section most likely depleted. Thus, a great part of the acid may be spent in a section in which little or no good can be accomplished. Generally the increase in recovery from limestone sections with a varying permeability profile will be substantially credited to increasing permeability in the tighter zones. Directing acid to these zones may either reduce resistance to flow already established, or it may open a new channel to a porous zone not previously connected to the well-bore.

Consequently the first problem is to determine at least an approximate permeability profile. Core analysis and electrical logs, while of great value in sand-pools, are frequently inadequate for such a determination in limestone reservoirs. Drilling time, sample analyses, drill-stem tests, etc., offer some information as to this determination, but often such testing was not performed, and in many instances it was incomplete and inconclusive. A permeability profile can be measured on a well without having any test data obtained while drilling. Fluid input tests can be conducted by selective input tests using packers after calipering the well-bore for locating packer points. The ability of different parts of a pay-zone to take fluid is an index of permeability. Probably the simplest method involves the use of an acid service company's "electric pilot," which can be used to detect the depth of an oil-water interface in a well. This permits determining an accurate permeability profile with or without tubing in a well.

Once the permeability profile is determined, selective acidizing programmes may be designed. Case histories are presented as illustrations. A. H. N.

804. Formation Gas Used to Lift Oil in West Texas. H. F. Simons. *Oil Gas J.*, 29.4.43, **41** (51).—A well in which the gas from an upper formation is used to drive the oil from a lower sand to the surface is described. The gas-sand was 3386–3393 ft., and the oil-sand was 3401–3418 ft., with a subsidiary zone at lower depths. A formation packer was run on 2½-in. tubing to 3395 ft. just below the gas-producing zone. The 2½-in. tubing extended about 15 ft. below the packer, and beneath it was a 20-ft. accumulator chamber of 4-in. flush-joint pipe. The standing valve was landed at 3430 ft., and beneath it was a short, flat-bottomed anchor with slots to hold the gravel in place and still permit passage of the fluid.

At 3300 ft. a bottom-hole operating valve was installed in the tubing, with a conductor pipe below it inside the tubing and accumulator chamber. This valve admits gas from the annular space above the packer into, and downward through, tubing and accumulator chamber below the packer. It also permits upward passage through the fluid-conductor pipe and valve-ports into the tubing above the valve. A pack-off-type tubing head on the casing with the usual valves, which were kept closed, was used at the surface. The bottom of the fluid-conductor pipe is properly spaced with reference to the standing valve, so that the packer may be collapsed if desired.

The bottom-hole valve was operated through a Nixon surface-controlled intermitter, which consists of a timing device which lifts and lowers a weight-bar suspended on a wire. As long as the valve remains closed, gas is confined in the annulus, but as soon as the timing cycle raises the bar the valve opens, gas is admitted into the accumulator chamber, and the oil trapped there is forced upward through the conductor pipe, valve, and tubing to the surface. A. H. N.

805. Relationship Between Velocity, Oil Saturation, and Flooding Efficiency. R. C. Earlougher. *Petrol. Tech.*, May 1943, *A.I.M.M.E. Tech. Pub. No.* 1592, 1–11.—Two of the most important factors concerning the recovery efficiency in the production of oil from sandstone reservoirs by water-drive are percentage of oil saturation and velocity of the water-flood. From radial water-flushing of fresh core samples in the laboratory, and a study of field data of numerous water-flood projects in North-eastern Oklahoma, it appears that for any given oil saturation there is a critical maximum velocity above which the oil-recovery efficiency falls off very rapidly. In the case of the laboratory experiments, the efficiency was reported as the percentage of the total oil recovered from the core when the water passed was equivalent to 5000 brl./ft. When a water-flood is operated above the critical velocity the injected water–oil ratio rises extremely fast, thus shortening the economic life of the flood and reducing the ultimate oil recovery. The critical velocity apparently varies considerably with the percentage oil saturation of the sand, so that the higher the oil saturation at the beginning of a flood the higher the velocity which can be used successfully.

It is concluded that most of the failures among some of the earlier floods in the Mid-continent were due to two things: (1) too low an oil saturation, *e.g.*, 30%; and (2) too high water-injection rates. Although considerably more field data are required to establish definite limits, it would seem that the proper field injection rate for a 330 by 330 or 440 by 440-ft. spacing varies from approximately 1 brl./ft. of sand/day, where the oil saturation is as low as 30%, up to 5 brl./ft. of sand/day, when the oil saturation is as high as 45–50%.

In laboratory experiments it is essential that original interstitial water be taken into account. G. D. H.

806. Remedial Work in the Oil-fields of the Eastern Area of the United States. W. N. Little. *Petrol. Tech.*, *A.I.M.M.E. Tech. Pub. No.* 1596, 1–11.—Pattern water-flooding oil-sands in New York and Pennsylvania, especially in the Bradford third sand, is an effective way of securing maximum secondary recovery of oil. A large acreage of this Appalachian area is currently being converted into water-flood operation, and Fettke estimated that in 1940 60% of the Pennsylvania grade crude from this area was being produced by water-flooding. Horizontal drilling from a shaft is being attempted in Franklin County, Pennsylvania. Gas injection has been used in a

number of fields, and pressure maintenance in the newer flush fields such as Louden gives indications of increasing primary recovery by 20–25% in some places.

The reconditioning methods used in the Appalachian fields include simple clean-cut, shooting, steaming, chemical treatment and acidization, and deepening. The methods of cutting and shooting a window are described in connection with opening upper zones. In most cases only zones that test as thieves are abandoned when new zones are opened, and the multiple zones are produced together and pumped from the deepest open formation.

It is easier and more economical to open an upper formation than a deeper one, and for the latter purpose cable tools are most often used unless there is much shale to be drilled. At Salem 104 wells have been deepened from the Devonian to the Trenton.

G. D. H.

807.* Development and Control of Oil Reservoirs. Part 1. S. E. Buckley and R. C. Craze. *Oil Wkly*, 3.5.43, **109** (9), 11. *Paper Presented before American Petroleum Institute.*—Recently a booklet, "Standards of Allocation of Oil Production," has been published summarizing present knowledge of production principles. This paper is a summary of the conclusions reached in the booklet. Oil-fields are divided into: (1) dissolved gas drive; (2) gas-gap drive; and (3) water drive. Each category is briefly discussed, and the chief characteristics and potentialities are given. The main questions in development are covered by:

(1) Enough wells must be drilled in any event adequately to explore and define the structure and to determine the gas- and water-levels. The only question involved in drilling, then, is the number of additional wells required and their spacing pattern. Money, labour, time, and materials spent in wells are largely irretrievable. It is not possible to back up from 5-, 10-, or 20-acre spacing. It is possible, however, to fill in from 40-, 60-, or 80-acre spacing, or any other exploratory pattern employed in outlining production. It seems obvious, therefore, that the prudent operator will not decide his ultimate well density in advance. He will drill as few additional wells as the conditions warrant, with the knowledge that he can fill in later should it prove necessary, rather than drill immediately as many wells as it is estimated can be afforded.

(2) In the matter of well completion, mistakes again will inevitably occur, but several simple considerations will cover most cases. (*a*) Wells should be completed in such manner as to exclude free gas and water. (*b*) Any well must take in sufficient producing section to yield oil at a reasonable rate. (*c*) Where this requirement does not conflict with requirement (*b*), it is good practice to open to production in a well only one separately identifiable producing horizon, thus providing for better subsequent control. The same result may in some cases be accomplished by multiple-zone completions. (*d*) Such purely mechanical details as whether to use screen, slotted-pipe, gravel-pack, or open-hole completion depend to a large extent on local sand conditions and have little or no bearing on reservoir performance.

The only remaining question is whether to complete wells in the top, bottom, or middle portion of a producing section. The proper position cannot be determined until the type of drive is known. Therefore the best completion is that which can most effectively and cheaply be changed when conditions warrant. In some areas casing cemented entirely through a producing section and perforated opposite a selected zone affords the best opportunity for successful later change of the producing interval.

A. H. N.

808.* Selective Shooting of Tight Sections Aids Stripper Wells. F. R. Cozzens. *Oil Wkly*, 3.5.43, **109** (9), 14.—The first step in selective shooting is to locate the tight sand and, if possible, to caliper it. The next step is to fill the hole with rubble rock, gravel, or some such material that can be easily drilled out. The hole is filled up to the base of the tight-sand section nearest the top of the pay. Tamping is done with the drill, so as to form a packed and even surface. A shell, filled with nitro-glycerine or gelatin, is run and seated on the surface of the packing material. The average nitro-glycerine shell is the common 4½-in. type, allowing 3·4 quarts/each ft. of hole. Some operators substitute the less expensive gelatin, 90% strength, which seems to give somewhat better results in certain types of sand, especially conglomerate formations. The gelatin cartridges generally used are 4 × 16 in., which allows approximately 7·4 lb. for each foot of sand.

The shells must be long enough to extend from the bottom to the top of the selected zone. After the loaded shell has been seated properly, so as to prevent its being floated out of position, a heavy anchor or stemming (usually water) is turned into the well, the average amount being one barrel of water to each foot of shell. All shots are of the electric type—blasting-cap in shell, and water-proofed connections made to copper-wire line which extends up and out of the hole.

After the charge is exploded the well is cleaned and tested. A. H. N.

809.* Proper Installation of Hydraulic Pumping Equipment. K. C. Vaughn. *Oil Wkly*, 3.5.43, **109** (9), 28.—Hydraulic pumping experience has dictated several simple but essential pre-requisites for satisfactory operation. These are: (1) dehydration facilities to meet the required demands; (2) reserve oil to provide uninterrupted operation for short periods; (3) wax control; (4) a central power that will guarantee ample power oil and contant supply; (5) arrangement of facilities in order to simplify operations; and (6) a programme for training personnel in the operation of hydraulic pumps. These are discussed in some detail.

A typical installation is described. It consists of five engines and hydraulic pumps, not including charging pumps. A separate motor-driven charging pump provides oil for the entire setting. This choice was made to reduce maintenance by eliminating five individual pumps, ten belt-drives, counter-shafts, housing, etc. It was felt that power failures were so infrequent that separate power source would not be troublesome. A few features included in this power setting are: (1) Flanged and welded fittings and plug-valves throughout to reduce leakage from vibration. (2) Elimination of the spacer-block scavenger pump. All drainage from the space-block is by gravity to main drainage system. (3) Elimination of all individual pressure gauges and installation of a recording pressure gauge. This gauge is invaluable in studying operation and it can be seen from the clutch of each engine. (4) Installation of a mercoid-operated relay switch to shut down engines in case of oil-supply failure. (5) Installation of starters on each engine. Engines are started from batteries in the pumper's car by means of a cable and plug. (6) Presence of an oil-bath gas-fuel scrubber.

To encourage "good housekeeping" and facilitate repair, a cement floor surrounds the setting. Deep drainage-pits under each pump and a sloping apron help to keep the setting clean and orderly. Drain lines, gas-fuel lines, electrical conduits, and relief oil lines are under the floor. Only the suction and discharge lines are located on the surface. The well manifold provides convenient access to the pumper, and can be easily dismantled and assembled by production crews. Use of knockout collars assures practically the same spacing each time a pump is re-run, and the location of unions at convenient points speeds up maintenance work. Power-oil meters and production meters are located together near the road circling each location. A positive-type rotary flow-bean is used to control input oil rate, and its use is helpful in maintaining pump speeds at chosen points. Combined with a constant-discharge pressure, these beans provide a common basis for comparison. In practice pump speeds are often difficult to obtain, and the results are inconsistent. Any control method based on speed alone requires considerably more supervision and attention. A. H. N.

810. Use of Materials in Secondary Recovery. P. D. Torrey. *Oil Gas J.*, 6.5.43, **41** (52), 114.—*Paper Presented before American Petroleum Institute.*—Large but little-recognized secondary reserves which are available to augment the primary reserves exist in the United States. The development of these reserves usually involves a minimum of new materials, it being frequently possible to utilize existing production facilities and wells. Percentage increases in production from secondary-recovery operations correspond to the increase in production brought about by the active development of a new field.

Prevention of corrosion in both gas-repressuring and water-flooding operations will serve to eliminate frequent replacements of equipment, and will thereby provide substantial savings in new materials. The successful application of flowing methods in water-flooding operations eliminates the need for all surface and sub-surface equipment commonly required to lift oil to the surface.

Unitization can provide savings in material and in operating expense by reduction in the number of plants and pipe-lines. A. H. N.

811. Removal of Paraffin Accumulations in the University Field. B. C. Craft and R. F. Nichols. *Oil Gas J.*, 6.5.43, **41** (52), 124.—*Paper Presented before American Petroleum Institute.*—A new paraffin scraper, which has resulted in a substantial reduction in scraping time, is described. This tool has been used in the University oil-field, where it is good practice to scrape each well twice weekly. It is believed that the tool may also be used successfully on wells produced by a surface-controlled gas-lift system. The body consists of a $\frac{3}{4}$-in. cold-rolled steel shaft, which is drilled with $\frac{3}{32}$-in. holes for the wires and tapped at right angles for Allen set-screws. The scratchers were made from 0·092-in.-diameter mild plough-steel wire, cut $2\frac{1}{2}$ in. long for $2\frac{1}{2}$-in. tubing. The two semicircular knives at the top are made of spring steel, are sharpened on top and bottom edges, and provide an open passage for the flow of cut paraffin and well-fluid. For $2\frac{1}{2}$-in. tubing the knives are $2\frac{1}{4}$ in. in diameter, and may be either welded or bolted to the steel bar.

This tool eliminates all the undesirable features of the circular knife or biscuit-cutter. The scratchers loosen and break the paraffin from the wall of the tubing into small chunks, and any accumulations remaining are removed by the overlapping circular knives. The paraffin is then, even at low rates of flow, carried up the tubing, with no danger of plugging the choke. It is believed that the combination of knives and scratchers more effectively cleans the tubing than the circular cutter, which leaves a thin layer of packed paraffin on the inside of the tubing. Wells, after being scraped with the latter, always cut harder than usual with the scratcher. A. H. N.

812.* Electric Pilot Promises Better Oil Recoveries. F. Briggs. *Oil Wkly*, 10.5.43. **109** (10), 13–16.—The device described is used to (1) determine a permeability profile of oil-wells; (2) spot or locate acid at any desired depth or for controlled use in any selected zone in the producing formation; (3) find the top of mud or other chemical bridges; (4) re-locate lost casing points or tubing bottom; and (5) determine the location of casing leaks.

Technically, the "electric pilot" is a fluid interface locater which causes an electric circuit to close upon submersion of this instrument in a conductive liquid or to break the circuit upon contact with a non-conductive medium or liquid. Simply, it is nothing more than a piece of apparatus lowered into the well by means of an insulated cable through which current will flow if the pilot is in (conductive) acid or salt water, and will not flow if it is in (non-conductive) oil. Thus, at the point where acid ends and oil begins, technically referred to as the "fluid interface," the pilot will only be lowered slightly into the conductive liquid before a current is noted, or raised slightly into the oil for the current flow to be broken. By holding the pilot electrode at the intermediate point of electrode contact, and knowing the depth of the pilot in the well, the interface is located.

The acid is pumped down the tubing, while the oil is introduced simultaneously into the tubing-casing annulus. In the case where selective acidizing is desired, the tubing is bottomed to the desired depth, the pilot seated in the tubing end, and acid entering from the surface passes through ports in the top of the pilot, down the hollow centre, and out through the perforated tail-piece. After passing through the pilot, which is suspended below the end of the tubing, the acid rises on the outside, and on reaching the first electrode, causes the electrical meter on the surface to show a half-scale deflection. On reaching the upper electrode, the acid face causes a full-scale deflection on the surface meter, thus indicating that the resistance connecting the two electrodes has been shorted out.

The use of the instrument to determine permeability profile and for other selective acidizing purposes is described. A. H. N.

813.* Development and Control of Oil Reservoirs. Part 2. S. E. Buckley and R. C. Craze. *Oil Wkly*, 10.5.43, **109** (10), 21.—*Paper Presented before American Petroleum Institute.*—The three types of drives—dissolved gas, gas cap, and water drives—outlined in Part 1 of the paper are further studied and methods of controlling reservoirs under each of these drives are discussed. After a long discussion, the general conclusion is that qualitatively it is easy to point out certain features of good and bad operation. The quantitative application to any specific field, however, is a complex and difficult matter, and the assumption that all fields are alike is both absurd and apt to be costly. It is imperative that each field be given individual and competent

technical study. Furthermore, the technologist cannot invent facts. The more that is known about a specific reservoir, the better the resultant interpretation and control of its behaviour. Adequate information on the producing zone and its contents, on the production of oil, gas, and water, and on the reservoir pressure is particularly essential. Unless such data are complete and reliable, even the best technologist may be misled.

It should be readily apparent that efficient operation requires proper control of a whole reservoir, and not merely part thereof. Good practice on one lease and bad practice on another do not necessarily average out to give a reasonably efficient average. The question, then, may well be raised as to the manner in which an operator whose properties comprise only a small fraction of a field can see to it that the whole field is operated efficiently Obviously his only recourse is co-operation with other operators, in the acquisition and exchange of necessary engineering data and in the acceptance and promotion of common good practice. The incentive lies in the possible greater return at less cost. A. H. N.

814.* Dual Completions Are a Sound Production Practice. E. O. Bennett. *Oil Wkly*, 10.5.43, **109** (10), 33.—The paper is written as an answer to a paper on "Some Objections to Dual Completions" which recently appeared in *The Oil Wkly*, and here the author denies that multiple completion results in only a small saving of steel, and that it would disturb markets or constitute operating difficulties and hazards. The paper takes each paragraph of the previous article and analyses its implications. Thus it was stated that dual completions would completely upset present proration systems, and that the permitting of higher allowables to dually completed wells would require re-distribution of market demand, taking away from single-zone wells and fields and adding to dual or multiple-zone wells and fields. On the theory proposed in this argument no more wells of any type should be drilled anywhere, because each new well would be a liability against those already completed. An oil-well must be considered as a vertical pipe-line, simply providing a means of moving oil from a supply zone to the surface. Should there be more than one supply zone in overlying position under the same surface acreage, there can be no difference in the effect of moving oil or other hydrocarbons from the separate zones by two wells, one within the other (dual completions), than would exist were separate wells drilled to each horizon. The theory or idea advanced sounds like one that might be expected from an operator who owned only single-zone pools, and for this reason alone does not want the producer who may be fortunate enough to own acreage in multiple-zoned areas to enjoy the benefits of his rights and fortunes of his exploratory ability.

To illustrate the saving in steel, it is mentioned that in one area on the Gulf Coast the steel saved by the use of dual-completions over that required for two single wells to the same zones is approximately 120 tons. A. H. N.

815. Wax Distillate Used to Plug Channels in Pay-Zone. H. F. Simons. *Oil Gas J.*, 13.5.43, **42** (1), 47.—Among the methods devised for prevention, or cure, of channelling is the plugging of the permeable streaks with a substance which will be fluid at elevated temperatures and liquid at the formation temperature. In the Pennsylvania water-flood region, petroleum wax has been used in several instances. A variation of the same method is being tried out in two North Central Texas water-floods, and in this case residual fuel having a high wax content is employed. The operator doing this work has a water-flood in the Prideaux area of Archer County, and another near Alney in Young County.

The wax distillate was first heated to approximately 120° F. and then pumped into the producing formation, from 15 to 50 brls. being used in each injection well. Pressures up to 600 lb./sq. in. were employed in placing the wax-oil used for plugging. A cementing truck was used for handling the fuel oil after it had been heated. The accepted theory of the action of the wax distillate is that when heated it will enter the more permeable zones and travel a considerable distance before it cools and congeals and blocks the pores in the sand. The less permeable portions take very little of the heated oil, and it penetrates only a short distance into them. After it has congealed, very little water can pass through it, and hence the water-drive is directed into the less permeable portions of the formation which contains the bulk of the oil.
A. H. N.

816. Economics of Water-Flooding. D. P. Oak. *Oil Gas J.*, 20.5.43, **42** (2), 49–51. *Paper Presented before American Petroleum Institute.*—There are four major considerations which an operator must take into account in a proposed water-flood. They are: (1) an oil reservoir suitable to water-flooding; (2) source and supply of water; (3) source and supply of power; (4) marketing facilities. Engineering and economics are so closely related in studying these factors that it is difficult not to digress into an engineering discussion. Preliminary estimates on water-flooding are at best very uncertain, due to: (1) the impossibility of obtaining sufficient data on which to base an estimate without an investigation, which would practically amount to a development; (2) the changing technique in the operation of a water-flood. Water-flooding in the Midcontinent field is only 10 years old, and we are only beginning to get complete histories. In the meantime technique has so changed that the history of the early floods is of little value in estimating future recovery. Each item is briefly discussed. Finally, the economics of the project is discussed under (1) production expense, (2) water-system expense, and (3) overhead and administrative expenses. Grouping all these expenses and starting with a minimum of 2000 brls./acre—as any intensively developed pumping project having less recovery than that cannot be a financial success at the present time—experience has shown that over the life of a project production expense will vary from 15 to 30 cents, water expense from 10 to 20 cents, and true administrative expense from 5 to 10 cents/barrel of oil produced. Totalling these items gives a minimum of 30 cents and a maximum of 60 cents/brl. of oil, with the lower recovery projects usually going into the high-expense brackets. A. H. N.

817. Flowing *versus* Pumping Operations in Water-Flooding. T. Lawry. *Oil Gas J.*, 20.5.43, **42** (2), 52. *Paper Presented before American Petroleum Institute.*—Delayed drilling programmes are discussed. Then the advantages of flowing over pumping are discussed in some detail. The first advantage is simplicity of operation. Except for a few of the very deep water-flood projects which operate by gravity, all water-floods have a pressure plant to force the flooding water into the sand under pressure. If that plant can be made to serve the dual purpose of putting water into the ground and taking the oil out, the mechanical problems have been reduced to their simplest form. And that is just what flowing involves. Instead of the pressure head being entirely expended in the formation, as is the case in pumping, part of it is reserved to lift the oil and water from the bottom of the oil-well to the surface, thus eliminating the need for central powers and pumping jacks, or individual pumping units to do the work. All the arguments over flowing revolve around this point of whether it is cheaper to risk not getting as much oil by flowing, or to do the job the expensive way by pumping to get what is it hoped will be more oil than would be obtained by flowing.

Savings in man-power and material are further advantages. A new technique used in water-flooding, and one that is best adapted to flowing projects, is that of limited withdrawal, similar to that used in flush-fields under proration where the day's production is taken in a few hours or minutes and the well shut in again for the remainder of the 24-hr. period. In water-flooding, the oil-wells are drilled when 100% liquid saturation is attained, and as nearly simultaneously as possible, so that all wells are at peak production at one time. When all the wells have been drilled, the packers on the bottom of the tubing cemented in, and the wells capable of being shut in under pressure, the oil-wells are flowed wide open for 1 or 2 days, to determine the potential of the lease, after which some pre-established time or fraction of the day from 18 to 22 hrs. is taken as the daily quota. The gauge is given to all switchers as the amount to take from that lease, and no more. For a day or two it will take that long to get the oil, but soon the time will have been reduced by ½ hr., then by 1 hr., and so on until possibly only 12 hrs. will be needed to obtain what formerly required almost a full day. In the meantime the oil-wells are shut in and allowed to pressure up with the intake wells going along unhampered 24 hrs. a day. The theory of this procedure is discussed. A. H. N.

818. North Texas Operators Turning to Water-Flooding to Increase Oil Recovery. H. F. Simons. *Oil Gas J.*, 3.6.43, **42** (4), 35.—Projects in North Texas, and especially in the Prideaux district, are discussed. Practically all the leases were originally developed on a spacing of a little over 300 ft. between wells. The general plan is to five spot, with the injection wells being located in the centre of the four wells.

In contrast to a number of water-floods, the projects in the Prideaux area use water obtained from shallower wells for injection purposes. This has a number of advantages, the main one being that its chemical composition is constant, and consequently an adequate treatment can be designed. Lifting costs have not been found to be excessive. The water-zone is found at 350–400 ft., the water being lifted with jack and sucker rods operated from the central power through a rod-line. These water-wells are equipped with a 6-in. working barrel, 4-in. tubing, and ⅞-in. sucker rods. The oil-wells in the area do not produce salt water but a brackish water which is almost palatable. The water from the wells is pumped into a 1600-brl. wooden tank used as a reservoir. The tank is also equipped with a small aerating tower, over which the water passes. Some alum is added to eliminate the algæ, and the pH is controlled with hydrated lime. The water from the storage then passes by gravity through a 2 × 8-ft. filter filled with graduated gravel, sand, fine anthracite coal, and a blanket of ferric chloride coagulent. The filter is equipped with a float-control which keeps it full at all times. Finished water is stored in a 250-brl. tank. A wash-back line from the finished-water tank is connected through the pump to the filters. From two to eight filters are used, depending on the volume of water needed. The maximum injection pressure expected is less than 550 lb./sq. in., but the triplex pumps used are capable of a greater output. These pumps have an 8-in. stroke and either a 3½-in. or a 3-in. bore, and will handle 2000–3000 brls./day at 50 r.p.m. The pumps are generally equipped with brass pistons. Engines for driving the pumps range from 15–25 h.p.

Cleaning and other operational details are discussed. A. H. N.

819. Gravel Loading of Formation Increases Production of Jal Field Wells. H. F. Simons. *Oil Gas J.*, 10.6.43, **42** (5), 39–40.—A frequent difficulty in wells with a low fluid-level is the caving of the formation in the uncased portion of the hole, with the result that the hole is partly or completely plugged and the movement of oil into the well-bore reduced. Gravel packing, in which variegated rock material is placed between the hole and a liner, is a common remedy for this trouble. A New Mexico superintendent has developed a slightly different practice, in that the hole is simply loaded with gravel to a point above the caving section. The method is simple, quick, and inexpensive, and the resulting increase in production from the wells is very encouraging. The process was applied to a formation with three or four pay horizons totalling 40–50 ft. The lower portion of the uppermost pay-streak in the wells was shot, leaving a fairly large cavity. This pay-streak supplied only a portion of the production, and the oil from the lower zones must be obtained if maximum production is to be gained. The exposed unproductive formations have a tendency to cave and fill the space between the hole and the tubing, bridging it and shutting off part of the pay-zones. The wells were produced with the standing valve immediately above the bottom of the hole, but the cavings, fortunately, did not freeze the tubing. However, the bridge was sufficiently tight to keep the wells from obtaining the maximum production.

The first step in reconditioning is to pull the tubing and lifting equipment from the wells and clean them out to the bottom. The wells are also swabbed, to pull any loose material into the hole, where it can be bailed or sand-pumped out. If the hole does not cave too badly this part of the operation takes 3 or 4 days. After the hole is clean, the gravel is poured into it in 20-gal. increments. After each batch is trickled in, the tools are run to bottom to gauge the fill-up. This process is repeated until the hole has been filled to about 15 ft. above the top of the shot cavity. The approximate size of the shot-hold can be obtained by measuring the fill-up from each batch of gravel. The pea gravel used for this purpose consists of material not larger than ½ in. and not smaller than ¼ in. Its cost is approximately 6 dollars per yard, and the largest quantity used to load a hole to date is approximately 650 gal. About 18 hrs. is required to place the gravel.

After the gravel has been placed, the tubing and production equipment are run back in the hole, and operations started. The standing valve is, of course, located immediately above the top of the gravel, instead of opposite the lower-most pay-streak. Oil can get into the well-bore, and the formation pressure is sufficient to keep it standing above the top of the gravel-pack, where the lifting equipment can pick it up.

A. H. N.

820. Unitized Pressure Maintenance, Jones Sand Reservoir, Shuler Field, Arkansas. G. R. Elliott. *Oil Gas J.*, 10.6.43, **42** (5), 53.—The early development of the field and the coming into force of the field maintenance programme are briefly discussed, together with the geology of the field. Core analysis and associated data are presented graphically, and the significance of certain results is discussed. Graphs also illustrate the discontinuous nature of the permeability profile. Continuous shale or silty partings between permeable zones would cause the injected gas to move parallel to the bedding, and restrict its vertical movement; the discontinuous character of such separations in this reservoir provides extremely favourable conditions for the gas-cap type of pressure maintenance. The injected gas, instead of finding a short path to the nearest producing well, disperses in various directions and in various planes, resulting in more effective moving of oil to the well-bores.

Using the productive sand volume of nearly 150,000 acre ft. calculated from the isopach map, and applying 1·45 initial formation volume factor, the initial oil-in-place is calculated to be 106,000,000 brls. if 35% connate water is assumed, or 122,000,000 brls. if 25% connate water is assumed. The Jones sand was discovered 17th September, 1937, and to the end of 1942 had produced 25,550,000 brls. of oil. It is shown for a continuation of primary operation, an estimated recovery of 34,000,000 brls. (this represents 30% recovery of 113,000,000 brls.). Under unitized gas injection of 90% of the produced gas volume, it was estimated that the ultimate recovery would be approximately 20,000,000 brls. even though the secondary operations were not begun until one-half of the primary production had already been recovered. A. H. N.

821. Patents on Production. R. Bassinger. U.S.P. 2,317,021, 20.4.43. Appl. 5.2.40. By-pass and releasing means for connecting a conductor with a well-tool.

W. H. Ellinger. U.S.P. 2,317,038, 20.4.43. Appl. 25.4.41. Paraffin solvent for use in removing paraffin from tubing wall and containing a softener and bentonite.

G. H. Ennis. U.S.P. 2,317,039, 20.4.43. Appl. 25.9.39. Method and apparatus for determination of water leakages into wells.

P. M. Goodloe and H. G Berger. U.S.P. 2,317,050, 20.4.43. Appl. 3.5.41. Breaking petroleum emulsions of water-in-oil type.

M. B. Thomas. U.S.P. 2,317,121, 20.4.43. Appl. 2.11.40. Gas-lift intermitter.

J. L. Porter and I. R. Funk. U.S.P. 2,317,219, 20.4.43. Appl. 16.7.40. Production of petroleum using gas anchor in a pumping well.

M. Mennecier. U.S.P. 2,317,238, 20.4.43. Appl. 17.6.41. Gunfire control apparatus for gun perforators in wells.

A. Boynton. U.S.P. 2,317,356, 27.4.43. Appl. 28.11.38. Bellows-type slugging foot-valve for wells.

K. Boedeker and K. Winnacker. U.S.P. 2,317,726, 27.4.43. Appl. 22.11.38. Breaking agent for emulsions from crude petroleum and salt water and a breakage of said emulsions.

G. L. Thompson and L. A. Cejka. U.S.P. 2,318,029, 4.5.43. Appl. 24.1.40. Intermittent gas-lift pump.

T. B. Wayne. U.S.P. 2,318,034, 4.5.43. Appl. 6.7.37. Emulsion breaking compound containing the $\alpha\beta$-enal grouping (—C=C—C=O) and an unsaturated chemical body.

T. B. Wayne. U.S.P. 2,318,035, 4.5.43. Appl. 25.3.39. Process and reagent for resolving emulsions.

J. H. Wiggins. U.S.P. 2,318,134, 4.5.43. Appl. 7.12.39. Seal for floating tank-roofs.

J. H. Wiggins, U.S.P. 2,318,135, 4.5.43. Appl. 24.5.40. Seal for floating tank-roofs.

L. R. Knowlton. U.S.P. 2,318,167, 4.5.43. Appl. 4.10.40. Liner setting and washing device for wells.

R. C. Johnston. U.S.P. 2,318,315, 4.5.43. Appl. 6.2.40. Polish rod rotator for pumping wells.

E. Cooper. U.S.P. 2,318,466, 4.5.43. Appl. 17.11.41. Protecting-apron for well-tubing.

W. J. Jones. U.S.P. 2,318,494, 4.5.43. Appl. 13.2.42 Surface rod-line jack for pumping wells.

L. R. Hodell and J. J. Heigl. U.S.P. 2,318,689, 11.5.43. Appl. 27.12.41. Tracing gas through underground formations.

H. J. Robertson and T. G. Wisherd. U.S.P. 2,318,714, 11.5.43. Appl. 24.1.40. Emulsion breaking by addition of aluminium chloride to oil-in-water types.

G. H. van Leeuwen. U.S.P. 2,319,020, 11.5.43. Appl. 18.9.36. Process for "impermeabilizing," tightening, or consolidating grounds and other earthy and stony masses and structures. A. H. N.

Gas.

822.* **Helium.** A. H. Stuart. *Petroleum*, March 1943, **6** (3), 45.—The general properties and characteristics of helium are described. The chief source of production is from the natural gases associated with certain petroleum deposits, chiefly in Texas, Kansas, Oklahoma, Ontario, and Alberta. The amount of helium present in these gases varies from a fraction of 1% up to about 16%. Helium is isolated by fractional distillation from the liquefied gaseous mixture, and the ratio of the amounts of helium and nitrogen present in the gases is of great importance from the aspect of commercial production as well as the actual helium content. The cost of production of helium of 98% purity by this process at the plant in Texas was just under 12 dollars per 1000 cu. ft. when producing about 1 million cu. ft. per annum, which is about 3½% of its potential capacity. In the past the main use of helium has been for the inflation of dirigible aircraft. Its unique properties—*viz.*, inertness, high specific heat, and high coefficient of thermal conductivity—may, however, lead to considerable commercial demand for helium in post-war days. It has already proved successful in the fire-proofing of high-tension switch-gear, where rapid dispersal of heat and freedom from corrosion of contacts are of importance, and as an atmosphere for the sputtering of beryllium and aluminium, and for the annealing of bright metals. A steady but small demand existed up to the outbreak of war for use in electric-discharge lamps.
R. A. E.

Hydrogenation.

823.* **Equipment and Control for the Determination of Catalytic Hydrogenation Rates.** N. K. Anderson and C. A. Rowe. *Industr. Engng Chem.*, 1943, **35** (5), 554.—For industrial process design it is desirable to obtain reaction rate data under flow conditions, since kinetic data obtained from static systems may not be applicable. For the solution of problems of the foregoing types, a detailed description is given of a suitable piece of equipment. The description includes methods of measuring and controlling temperature, pressure, flow rates, and feed ratios. J. W. H.

824.* **Determination of Catalytic Hydrogenation Rates.** R. B. Beckmann, A. E. Pufahl, and O. A. Hougen. *Industr. Engng Chem.*, 1943, **35** (5), 558.—With the apparatus described by Anderson and Rowe (*ibid.*, p. 554) the reaction rates of the catalytic hydrogenation of *iso*-octene to *iso*-octane have been studied in the vapour phase under continuous-flow conditions with a nickel catalyst. Data are given for the reaction at 250° C. and 5 atmos. total pressure, and, from a correlation of the results, reaction rate equations are developed which show the effects of activated adsorption and surface reaction in terms of concentrations for two catalysts.
J. W. H.

Refining and Refinery Plant.

825.* **Design of Solid Fluid Heat Exchangers.** C. L. Lovell and G. Karnofsky. *Industr. Engng Chem.*, 1943, **35** (4), 391.—The data presented in this article are of value in estimating the heat transfer from gases to catalysts. Methods are given for solving

problems involving the transfer of heat under continuous parallel or counter-current conditions. To simplify the calculations graphical constructions are demonstrated.
J. W. H.

826.* Fractional Distillation of Binary Mixtures. Number of Theoretical Plates and Transfer Units. A. J. V. Underwood. *J. Inst. Petrol.*, **29** (234), 147.—The problem is treated mathematically. For binary mixtures with constant relative volatility the number of transfer units can be calculated in a form which readily permits of comparison with the number of theoretical plates required for the same separation. The computation can in both cases be greatly facilitated by using simple graphical method. Any separation with finite reflux can be exactly converted into an equivalent separation with total reflux by using a modified relative volatility and modified compositions.
A. H. N.

827.* Recent Developments in Welding. C. W. Brett. *J. Inst. Petrol.*, **29** (234), 157–162.—A well-illustrated paper on welding, metal-spraying, and other repair work in which molten metal is used, is presented. A process was recently perfected which made a clean sweep of most preconceived notions on the subject. It resulted in the achieving of a truly welded union with almost any combination of metals. This important fact is not generally realized, and so far only a few industries, among them the electrical trade in particular, have grasped its importance. Quite apart from repair work, for which the system was primarily evolved, its influence on new production will be potent, to say the least. Aluminium can be welded to steel if needs be, but however striking the dissimilarity between the two metals, tests to destruction, by exerting an increasing pull until something must break, always cause the weaker parent metal to fail first, whilst the weld invariably holds fast. A. H. N.

Chemistry and Physics of Hydrocarbons.

828. The Reaction of Epichlorohydrin with the Grignard Reagent. J. K. Magrane, Jr., and D. L. Cottle. *J. Amer. chem. Soc.*, 1942, **64**, 484–487.—The alkoxide from either epichlorohydrin and magnesium bromide, or from 1-bromo-3-chloro-2-propanol and ethyl magnesium chlorobromide, gave ethane, ethylene, and a product with the properties expected of *cyclo*propanol on reacting with ethyl magnesium bromide. This supports the theory that ethylene oxides react spontaneously with both the alkyl magnesium and magnesium bromide bonds.

Epichlorohydrin with ethyl magnesium bromide direct also gave a product that appeared to be *cyclo*propanol. E. H. W.

829. Hydrogenation of Alkyl Phenyl Ketones in the Presence of Copper Alumina Catalysts. V. N. Ipatieff and V. Haensel. *J. Amer. chem. Soc.*, 1942, **64**, 520–521.—A copper-aluminium catalyst containing 2·5–8% Al_2O_3 (on the reduced basis) has been found to hydrogenate ketones without affecting the benzene nucleus. A number of *n*-alkyl phenyl ketones were thus hydrogenated at 115° C., producing *n*-alkyl phenyl carbinols, and it was shown that butyrophenone and valerophenone were more difficult to hydrogenate than any of the other *n*-alkyl phenyl ketones tried. Using the same catalyst, the carbinols could be converted at 150–180° C. into the corresponding alkyl benzenes, giving yields of 95–98%. E. H. W.

830. An Acetylenic Analogue of Neopentyl Bromide; Evidence that the Hindrance to Displacement Reactions in Neopentyl Halides is Steric in Nature. P. D. Bartlett and L. J. Rosen. *J. Amer. chem. Soc.*, 1942, **64**, 543–546.—1-Bromo-4 : 4-dimethylpentyne-2 showed no sign of hindrance compared with 1-bromo-heptyne-2, in exchange reactions with potassium iodide in acetone solution. The rates of reaction of other related bromides treated with potassium iodide in acetone solution are also given. From the results it is concluded that the hindrance effect shown in neopentyl alcohol and halides is steric rather than chemical. Space models of neopentyl compounds and the reactivities of the compounds studied also support the above conclusion.
E. H. W.

831. Vapour Pressures and Critical Constants of *iso*Butene. J. A. Beattie, H. G. Ingersoll, and W. H. Stockmayer. *J. Amer. chem. Soc.*, 1942, **64**, 546–548.—Measurements of the vapour pressure of *iso*butene between 30° C. and 125° C. are given. Good agreement was obtained between the observed vapour pressures and calculated values from a two-constant equation. Critical constants determined by the compressibility method were: $t_c = 144{\cdot}73 \pm 0{\cdot}05°$ C. (Int.); $p_c = 39{\cdot}48 \pm 0{\cdot}05$ normal atmosphere; $v_c = 0{\cdot}240$ litre/mole (4·28 c.c./g.); $d_c = 4{\cdot}17$ mole/litre (0·234 g./c.c.). The uncertainty in the critical volume and density is 1%. Benedict's results for critical pressure and temperature, obtained by the disappearance of the meniscus method, are in good agreement with those given above. E. H. W.

832. The Compressibility of and an Equation of State for Gaseous *iso*Butene. J. A. Beattie, H. G. Ingersoll, and W. H. Stockmayer, *J. Amer. chem. Soc.*, 1942, **64**, 548–550.—Compressibility measurements of gaseous *iso*butene from 150° C. to 275° C. and from a density of 1·0–9·0 mole/litre are reported, the maximum pressure being 250 atm. Polymerization of the *iso*butene in a glass-lined bomb did not seriously affect the compressibility determinations below 275° C. Constants for the Beattie–Bridgeman equation of state were determined from the data up to the critical density, and the calculated and observed pressures are compared. Calculated values of the second virial coefficient are also given from 150° C. to 275° C. E. H. W.

833. Polyphenylnaphthalenes. I. 1 : 2-Diphenylnaphthalene. F. Bergmann, H. E. Eschinazi, and D. Schapiro. *J. Amer. chem. Soc.*, 1942, **64**, 557–558.—A synthesis of 1 : 2-diphenylnaphthalene is described. Starting from α-phenyl-β-benzoylpropionic acid, a two-stage reduction process gave α, γ-diphenyl butyric acid. This on cyclization by a Friedel–Crafts reaction gave a tetralone which, with phenyl magnesium bromide, produced 1 : 2-diphenyl-3 : 4-dihydro-naphthalene, and the latter compound was then dehydrogenated to 1 : 2-diphenylnaphthalene by the addition of lithium. E. H. W.

834. Polyphenylnaphthalenes. II. 1 : 2 : 3-Triphenylnaphthalene. F. Bergmann, D. Schapiro, and H. E. Eschinazi, *J. Amer. chem. Soc.*, 1942, **64**, 559–561.—1 : 2 : 3-Triphenylallyl-sodium with carbon dioxide, then hydrogenation, gives α, β, γ-triphenylbutyric acid. A tetralone derivative is then obtained which, with phenyl magnesium bromide, gives 1 : 2 : 3-triphenyl-3 : 4-dihydronaphthalene and on dehydrogenation gives 1 : 2 : 3-triphenylnaphthalene. E. H. W.

835. The Decomposition of Certain Acetylenic Carbinols. A. F. Thompson, Jr., and C. Margnetti. *J. Amer. chem. Soc.*, 1942, **64**, 573–576.—The preparation and properties of a number of acetylenic tertiary carbinols are described. These carbinols were then decomposed over commercial alumina. A simple dehydration takes place with alkylethynyl substituents, but ethynyl and phenylethynyl substituents yielded the acetylenic hydrocarbon and the ketone. In aqueous potassium hydroxide solution the cleavage of the acetylenic group occurs generally for all the hydrocarbons investigated. E. H. W.

836. Alkyl Carbonates in Synthetic Chemistry. III. Condensation with Nitriles. Synthesis of α-Cyano Esters. V. H. Wallingford, D. M. Jones, and A. H. Homeyer. *J. Amer. chem. Soc.*, 1942, **64**, 576–578.—Aliphatic nitriles and aryl acetonitriles, on treating with sodium or potassium alcoholate in a large excess of alkyl carbonate, yielded α-cyano esters. Lower members of the aliphatic series gave poor yields, and unsaturated compounds tended to give tars. E. H. W.

837. Alkyl Carbonates in Synthetic Chemistry. IV. Alkylation of Malonic Esters by Alkyl Carbonates. V. H. Wallingford and D. M. Jones. *J. Amer. chem. Soc.*, 1942, **64**, 578–580.—Ethyl, butyl, *iso*butyl, *iso*amyl, and benzyl groups were introduced by the corresponding carbonates into the metal derivatives of a variety of malonic esters. Malonic ester itself was not alkylated, but mono-substituted malonic esters were successfully alkylated for any chain-length provided it was a primary aliphatic group.

Poor yields were obtained using secondary carbonates, and also if the substituent of the malonic ester was a secondary aliphatic group, but good yields were obtained with phenyl- and benzyl-substituted malonic esters. E. H. W.

838. Alkyl Carbonates in Synthetic Chemistry. V. Alkyl Carbonates as Solvents for Metalation and Alkylation Reactions. V. H. Wallingford, M. A. Thorpe, and A. H. Homeyer. *J. Amer. chem. Soc.*, 1942, **64**, 580–582.—Metalation and alkylation of malonic esters, β-keto esters and α-cyano esters has been successfully accomplished, using alkyl carbonates as reaction media. In this way formation of the metal derivative is completed without cleavage by alcoholysis taking place. The preparation is reported of several new malonic esters, including some containing two *s*-butyl groups which have previously been unobtainable by usual methods. E. H. W.

839. Brucine as a Reagent for Partially Resolving Bromoalkanes; the Configurations of some Diastereomeric Dibromoalkanes. H. J. Lucas and C. W. Gould, Jr. *J. Amer. chem. Soc.*, 1942, **64**, 601–603.—Using brucine, and under identical conditions, one isomer of dibromoalkane becomes optically active, while the other does not. This partial resolution is due to a difference in the rates with which antipodal dibromoalkanes react with brucine. The effect of adsorption was negligible. There was no conversion of a *dl*- to a *meso*-form or *vice versa* with 2 : 3-dibromobutanes, 3 : 4-dibromohexanes, or 4 : 5-dibromo-octanes. The *dl*-isomer when treated with brucine becomes optically active, while the *meso*-form does not. Configurations previously assumed for these symmetrical dibromoalkanes are confirmed. E. H. W.

840. Reactions with Tetraphenyl*cyclo*pentadienone. Condensation with Cyclic 1 : 3-Diene Systems. O. Grummit, R. S. Klopper, and C. W. Blenkhorn. *J. Amer. chem. Soc.*, 1942, **64**, 604–607.—Tetraphenyl*cyclo*pentadienone would not condense with furan, pyrrole, N-methyl-pyrrole, or thiophene. With *cyclo*pentadiene an addition product was obtained containing one molecule of each of the reactants. From a series of reactions the compound formed was inferred to be 4 : 7-endocarbonyl-8 : 9-dihydroindene. It is suggested that the lower resonance energy of *cyclo*pentadiene compared with the other compounds tried is the reason for its reaction with tetraphenyl*cyclo*pentadienone. E. H. W.

841. Kinetics of the Hydrogen Fluoride Catalyzed Reaction between Toluene and *t.*-Butyl Chloride. J. W. Sprauer and J. H. Simons. *J. Amer. chem. Soc.*, 1942, **64**, 648–659.—This paper presents a study of the kinetics of the reaction between toluene and *t.*-butyl chloride when catalysed by hydrogen fluoride, the course of the reaction being followed by measurement of the hydrogen chloride evolved. The reaction is homogeneous, and proceeds at a measurable rate at 25° C., and it is of first order with respect to *p-t.*-butyl chloride, which is produced quantitatively under a wide range of conditions. The reaction is approximately proportional to the 5·5 power of the hydrogen fluoride pressure. Oxygen had no catalytic effect, but small amounts of water or methyl alcohol had very marked accelerating effects. From the results a detailed discussion of the possible mechanisms of the reaction is given. E. W. H.

842. Halogen Addition to Ethylene Derivatives. I. Bromine Additions in the Presence of Bromide Ions. K. Nozaki and R. A. Ogg, Jr. *J. Amer. chem. Soc.*, 1942, **64**, 697–704.—The equilibrium constant for the dissociation of potassium tribromide in glacial acetic acid has been determined at three temperatures. A study was made of the action of bromine in the presence of lithium bromide on maleic and fumaric acids. The initial products were dibromides, which could only be accounted for by a *trans*-addition. Rate measurement data fitted best the rate expression :

$$-\frac{d(\mathrm{Et})}{dt} = k_a[\mathrm{Br_3^-}][\mathrm{Et}] = \frac{k_a}{K}[\mathrm{Br_2}][\mathrm{Br^-}][\mathrm{Et}]$$

where [Et] represents the concentration of the ethylene derivative. The rate of reaction was higher in solutions of low ionic strength. Addition of other salts as well as lithium bromide retarded the reaction, indicating this retardation to be a salt effect.

A much better catalyst than lithium bromide for the addition of bromine to maleic and fumaric acids was found to be hydrobromic acid, The same rate expression was followed, but the rate of reaction was proportional to the concentration of proton doners. While neither light nor oxygen had any effect on the lithium-bromide or hydrobromic-acid-catalysed reactions, added water retarded the latter reaction to a greater degree. The addition of bromine to vinyl bromide in glacial acetic acid was studied kinetically. This reaction was also catalysed by lithium bromide, and the same rate expression satisfied when the concentration of bromide ions was much higher than that of bromine. The reaction was not affected by the ionic strength of the solution or the concentration of proton doners, in contrast with the corresponding reactions with maleic and fumaric acids, thus verifying the authors' suggestion that these latter effects were due to the presence of the carboxyl group. The same catalytic effect was shown by hydrobromic acid and lithium bromide in the action of bromine on allyl chloride. With allyl acetate, hydrobromic acid showed a somewhat better catalytic effect; the difference between the two catalysts, however, was much less marked than with maleic and fumaric acids. E. H. W.

843. Halogen Addition to Ethylene Derivatives. II. The Mechanism of the Halide Ion Catalysed Addition Reactions. K. Nozaki and R. A. Ogg, Jr. *J. Amer. chem. Soc.*, 1942, **64**, 704–708.—In nearly all previous studies of halogen addition to ethylene derivatives the halogen molecule and halide ion were from the same element. This paper reports the effects of other ions, some not halides, all in glacial acetic acid as solvent. Bromine and vinyl bromide react autocatalytically, but addition of lithium bromide causes a greatly increased consumption of bromine. The kinetic data conformed best to the rate expression $-\frac{d(\mathrm{Et})}{dt} = k[\mathrm{Br_2}][\mathrm{Cl^-}][\mathrm{Et}]$, where Et represents the ethylene derivative, *i.e.*, vinyl bromide. The reaction was of first order with respect to the concentrations of vinyl bromide, bromine, and lithium chloride. Bromine addition to allyl chloride was catalyzed by acetate, bisulphate, and nitrate ions, as well as halide ions, but cations had no effect. Addition of iodine to allyl chloride was also catalysed by electrolytes.

Mechanisms of the halide catalysed reactions are discussed. The one giving better correlation with experimental facts involves a termolecular reaction between the unsaturated compound, the halide ion, and the halogen molecule.

Preliminary complexes may be formed between the ethylene derivative and the halide ion, but it is suggested that in general the addition to the double bond occurs by simultaneous and joint action of the halide ion and the halogen molecule. In some cases, however, association between the ethylene derivative and either the halide ion or halogen molecule may precede a reaction with the other molecule. E. H. W.

844. Halogen Addition to Ethylene Derivatives. III. Bromine and Iodine Additions in Glacial Acetic Acid. K. Nozaki and R. A. Ogg, Jr. *J. Amer. chem. Soc.*, 1942, **64**, 709–716.—The reaction of bromine with allyl chloride in glacial acetic acid is shown to be complex, by the mixture of products and by the rate expression:

$$-\frac{d(\mathrm{Et})}{dt} = k_c[X_3^-][\mathrm{Et}] + k_b[X_2][\mathrm{Et}] + k_c[X_2]^y[\mathrm{Et}] \quad . \quad . \quad . \quad . \quad (1)$$

where Et represents the ethylene derivative, *i.e.* allyl chloride, X represents the halogen, and $y > 2$. The results of kinetic studies at three temperatures are given. The reaction was extremely sensitive to added water, but was unaffected by packed reaction vessels or atmospheres of oxygen or carbon dioxide. Addition of bromine or iodine to allyl acetate gives rise to similar reactions which require an analogous rate expression and which have similar characteristics. The action of iodine on allyl alcohol was shown to be even more complex, being of a higher order than the second with respect to iodine, and of higher order than the first with respect to allyl alcohol concentration. A detailed discussion is given of the mechanisms of these halogen addition reactions. Each of the three right-hand terms in the rate expression (1) are taken to represent a different addition process, and each is discussed separately. The first term corresponds to the halide ion catalysed reaction (see previous abstract). The second term has been assumed to correspond to a reaction in which a haloacetate and hydrogen halide are

produced. Results presented in this paper indicate that a reaction probably of third or higher order with respect to halogen concentration is involved. This reaction is represented by the third term in the expression. Conflicting results reported in the literature are explained on the basis of this complex rate expression. E. H. W.

845. Magnetic Susceptibilities of *Cis*- and *Trans*-Decalin. Note by W. Byerly and P. W. Selwood. *J. Amer. chem. Soc.*, 1942, **64**, 717–718.—Magnetic susceptibilities of *cis*- and *trans*-decalin at 35° C. are reported as: $-0{\cdot}774 \times 10^{6}$ and $-0{\cdot}779 \times 10^{6}$ respectively. The significance of the small difference between the two values is discussed. E. H. W.

846. 1 : 2-Diphenyl-3 : 4-dihydronaphthalene. Communication from H. M. Crawford. *J. Amer. chem. Soc.*, 1942, **64**, 727–728.—Melting points of the compound obtained by Bergmann *et al.* (*J. Amer. chem. Soc.*, 1942, **64**, 557) have been compared with the same compound from a different preparation by this author.

The explanation of the difference in the two melting points is suggested to be due to the fact that the two compounds are physical isomers, one of a high-melting form and the other a low-melting form. E. H. W.

847. The Action of Hydrogen Fluoride, Sulphuric Acid, and Phosphoric Acid on Optically Active 2-Butanol. R. L. Burwell, Jr. *J. Amer. chem. Soc.*, 1942, **64**, 1025–1031.—With sulphuric acid, racemization of optically active 2-butanol proceeds more rapidly than dehydration, polymerization, or alkylation. The racemization with equimolecular mixtures is of the first order with respect to the alcohol, but decreases with increasing concentrations of water. The general action of hydrogen fluoride is similar, but a much larger acid–alcohol ratio is needed.

It is suggested that, partly because of its lower activity, phosphoric acid produced only slight racemization under any of the conditions studied. E. H. W.

848. The Alkylation of Benzene in the Presence of Acid Catalysts. R. L. Burwell, Jr., and S. Archer. *J. Amer. chem. Soc.*, 1942, **64**, 1032–1034.—This paper describes the alkylation of benzene by optically active *s*.-butyl alcohol in the presence of hydrofluoric, sulphuric, and phosphoric acids, and also boron trifluoride. *s*.-Butyl benzene was produced showing rotations of opposite signs to those of the original alcohols. E. H. W.

849. The Heat Capacity and the Vapour Pressure Hysteresis in Liquid *iso*Pentane. Isomers due to Hindered Rotation. J. G. Aston and S. C. Schumann. *J. Amer. chem. Soc.*, 1942, **64**, 1034–1039.—In this paper a graph is given of the heat-capacity data obtained on liquid *iso*pentane between 180° K. and 240° K. Points are given for more than twenty various treatments of the sample. Hysteresis effects have been found, both in the heat capacity and also in vapour-pressure measurements, these effects being about 100 times the precision of the instrument. The authors suggest the slow transfer of one isomeric form into another made possible by restricted rotation as an explanation of these results. E. H. W.

850. The Heat Capacity and Entropy, Heats of Fusion and Vaporization, and the Vapour Pressures of *iso*Pentane. S. C. Schumann, J. G. Aston, and M. Sagenkahn. *J. Amer. chem. Soc.*, 1942, **64**, 1038–1043.—This work is a continuation of that reported in the preceding abstract, and the material used, method, and accuracy are the same as for that paper. Heat-capacity measurements are given between 20° K. and 290° K., vapour pressures between 217° K. and 290° K. The melting point, normal boiling point, heats of fusion, and vaporization are also reported. From an empirical equation for vapour pressure calculated values for boiling point and heat of vaporization are given. The molal entropies in the liquid and gas state are also calculated.

The free energies of neopentane, *iso*pentane, and *n*-pentane at 298° K. calculated from this and other work are tabulated. E. H. W.

851. Ketene Acetals. IX. Ketene Dialkylacetals. S. M. McElvain and P. M. Walters. *J. Amer. chem. Soc.*, 1942, **64**, 1059–1060.—The preparation and properties of ketene di-*n*-propyl-, di*iso*butyl-, and di*iso*amyl-acetal are recorded. The properties of the

compounds prepared by Schrieber and his collaborators (*Ann.*, 1927, **458**, 21), and claimed to be the same as the above ketene acetals, are shown to be different.
E. H. W.

852. Certain Derivatives of the Octadecenoic Acids. I. The *p*-Phenylphenacyl Esters. II. The *S*-Benzylthiuronium Salts. J. P. Kass, J. N. Nichols, and G. O. Burr. *J. Amer. chem. Soc.*, 1942, **64**, 1061–1062.—The *p*-phenylphenacyl esters of oleic, elaidic, linoleic, linolelaidic, linolenic, β-eleostearic, and α-tetrabromostearic acids were prepared. The melting points were satisfactory, but among the unsaturated derivatives, only the already known esters of the first two acids mentioned gave iodine numbers agreeing with the calculated values. For various reasons, none of the *S*-benzylthiuronium salts of any of the above acids was suitable for identification purposes.
E. H. W.

853. The Utilization of Aliphatic Nitro-Compounds. III. Nitroalcohols Prepared from Aldehydes Containing No Other Functional Group. C. A. Sprang and E. F. Degering. *J. Amer. chem. Soc.*, 1942, **64**, 1063–1064.—The preparation and some physical constants of twenty nitro-alcohols are reported.
E. H. W.

854. Alkanolamines. XI. Monoalkylamino Alcohols and their Esters. C. B. Kremer and E. Waldman. *J. Amer. chem. Soc.*, 1942, **64**, 1089–1090.—The preparation of a series of new monoalkylamino-alcohols and their *p*-nitrobenzoates is reported.
E. H. W.

855. Addition Polymerization Catalysed by Substituted Acyl Peroxides. C. C. Price, R. W. Kell, and E. Krebs. *J. Amer. chem. Soc.*, 1942, **64**, 1103–1106.—Polystyrene and polymethyl methacrylate prepared in the presence of chloroacetylperoxide, *p*-bromobenzoylperoxide, or anisoylperoxide, contained on the average from a half to two and a half groups derived from the peroxide per polymer molecule. These results support the suggestion that free radicals from the thermal decomposition of the peroxide catalysts initiate the polymerization.
E. H. W.

856. Branched-Chain Fatty Acids. I. Synthesis of 17-Methyloctadecanoic Acid. J. Carson. *J. Amer. chem. Soc.*, 1942, **64**, 1106–1110.—The reaction of an alkyl cadmium compound with the acid chloride of a half ester has been used successfully in this synthesis of 17-methyloctadecanoic acid. This work begins a proposed series of syntheses of methyl-stearic acids.
E. H. W.

857. A New Method of Synthesizing Aliphatic Difluorides. M. W. Renoll. *J. Amer. chem. Soc.*, 1942, **64**, 1115–1116.—The paper describes the synthesis of five aliphatic difluorides, from butane to octane, by the action of monochloro-olefins and anhydrous hydrogen fluoride under pressure at moderate temperature. Physical properties of three new compounds, $C_2H_5CF_2C_2H_5$, $CH_3CF_2CH_2CH(CH_3)_2$, and $CH_3CF_2(CH_2)_5CH_3$, are given.
E. H. W.

858. The Cleavage of Ethers with Boron Bromide. I. Some Common Ethers. F. L. Benton and T. E. Dillon. *J. Amer. chem. Soc.*, 1942, **64**, 1128–1129.—When cleaved by boron bromide, simple alkyl ethers yielded alcohols and alkyl bromides, while mixed alkyl phenyl ethers yielded phenols and alkyl bromides. Further work on the action of boron bromide on ethers is proceeding.
E. H. W.

859. The Structures of Methylene*cyclo*butane and Hexamethylethane. S. H. Bauer and J. Y. Beach. *J. Amer. chem. Soc.*, 1942, **64**, 1142–1147.—Although configurations of these two compounds are known from chemical data, this investigation by electron diffraction was made to verify the accepted structures.

The results were: (*a*) Methylene*cyclo*butane carbon atoms are co-planar, four of them on the average at the corners of a square with (1·56 ± 0·03 Å. on the side) and the fifth on an extension of one of the diagonals (1·34 ± 0·02 Å. from the carbon atom in the ring), (*b*) Hexamethylethane c–c distances are all 1·54 ± 0·02 Å., with the excep-

tion of the central c–c distance, which is probably 1·58 ± 0·03 Å. Carbon valence angles are 111 ± 2°; C–H = 1·09 Å. was assumed. E. H. W.

860. The Preparation and Directed Chlorination of 1 : 1 : 1-Trifluoropropane. A. L. Henne and A. M. Whaley. *J. Amer. chem. Soc.*, 1942, **64**, 1157–1159.—$CH_2CH_2CCl_3$ would not yield $CH_2CH_2CF_3$ by halogen exchange owing to loss of hydrogen chloride. A successful synthesis was accomplished starting from $CH_2CH = CCl_2$ (prepared from readily available material) which yielded the desired product by halogen exchange. $CH_2ClCH_2CF_3$, $CHCl_2CF_3$, $CCl_2CH_2CF_3$, and $CCl_2CCl_2CF_3$, were successively yielded by chlorination of $CH_2CH_2CF_3$ in sunlight, thus verifying the strongly directing effect of fluorine. No evidence for a tetrachloride was found, the chlorination proceeding directly from a trichloride to a pentachloride. A list of new fluorochloropropane derivatives with their physical properties is given, and also the verifications of their formulæ. E. H. W.

861. The Dipole Moment of a Free Radical. J. Turkevich, P. F. Oesper, and C. P. Smyth. *J. Amer. chem. Soc.*, 1942, **64**, 1179–1180.—Dipole measurements of α, α-diphenyl-β-picryl hydrazine, and of the free radical, α, α-diphenyl-β-picrylhydrazyl have been measured. The results are discussed and compared with previous readings. E. H. W.

862. Raman Spectra of some Aromatic Carbonyl and Nitro-Compounds. M. J. Murray, F. F. Cleveland, and R. H. Saunders. *J. Amer. chem. Soc.*, 1942, **64**, 1181–1184.—Raman frequencies, estimated intensities, and depolarization factors are reported for acetophenone, mesitylaldehyde, acetylmesitylene, methyl-2 : 4 : 6-trimethylbenzoate and 2 : 4 : 6-trimethylbenzoyl chloride.

Three new lines are reported for acetopheone, the only compound of this series on which previous results were known to the authors. E. H. W.

863. Catalytic Addition Reactions of Acetylenic Alcohols. G. F. Hennion and W. S. Murray. *J. Amer. chem. Soc.*, 1942, **64**, 1220–1222.—The actions of methanol and acetic acid with dimethylethynl-carbinol in the presence of mercuric oxide and boron fluoride are reported in *J. Amer. chem. Soc.*, 1940, **62**, 653. It has now been shown that representative acetylenic alcohols condense with (*a*) methanol to form a number of substituted dioxanes, (*b*) ethylene glycol to form various dioxolanes, and (*c*) acetic acid to give acyloin acetates.

Physical constants, yields, and analytical data for the products obtained are given. E. H. W.

864. The Heat Capacity of Organic Vapours. III. Nitromethane. Note by T. de Vries and B. T. Collins. *J. Amer. chem. Soc.*, 1942, **64**, 1224–1225.—These authors report heat-capacity data for nitromethane which shows excellent agreement with the results of Pitzer and Gwinn (*J. Amer. chem. Soc.*, 1941, **63**, 3313). E. H. W.

865. Mechanical Properties of Substances of High Molecular Weight. II. Rigidities of the System Polystyrene–Xylene and their Dependence on Temperature and Frequency. J. D. Ferry. *J. Amer. chem. Soc.*, 1942, **64**, 1323–1329.—Solutions of polystyrene in xylene will support transverse vibrations and therefore possess rigidity. The propagation of transverse vibrations through solutions ranging from 15·3 to 52·3% polymer at temperatures of −5 to 40° C. and frequencies between 200 and 4000 cycles have been studied. Dispersion and damping effects are described and from the observations was obtained a relaxation time of about 4×10^{-4} sec., this was independent, to a first approximation, of temperature and concentration.

The modulus of rigidity was calculated from the velocity of wave propagation, and in the range studied varied between 10^4 and 10^6 dynes/cm.$^{-2}$. The results are discussed in terms of the molecular behaviour of long-chain polymers. E. H. W.

866. Mechanical Properties of Substances of High Molecular Weight. III. Viscosities of the System Polystyrene–Xylene. J. D. Ferry. *J. Amer. chem. Soc.*, 1942, **64**, 1330–1336.—At temperatures between 1° C. and 30° C. the viscosities of solutions of

15·4–52·3% polystyrene in xylene have been measured in a Stormer viscosimeter. The dependence of the viscosity on shearing stress, temperature, and concentration is described and discussed. More concentrated solutions showed elastic recoil. From the data, information was obtained on a modulus of rigidity representing recoverable deformation under steady flow and a time function related to a relaxation function. Viscosity and rigidity data from this and the previous paper are interpreted by two molecular mechanisms. The first mechanism is associated with a modulus of rigidity of the order of 104 dynes/cm.$^{-2}$, which is proportional to the concentration (up to 30%), and a mean relaxation time which varies with the concentration and is roughly proportional to the macroscopic viscosity. This mechanism is postulated to be the uncurling of flexible molecules. In the second mechanism the modulus of rigidity is proportional to the third power of the concentration (up to 30%) and the relaxation time is independent of concentration, and hence viscosity. The suggestion is made that this second mechanism is connected with the bending of carbon–carbon bonds.

E. H. W.

867. Reactions of Bromine with Carbon Tetrachloride and Tetrachloroethylene Following Neutron Capture and Isomeric Transition. E. G. Bohlman and J. E. Willard. *J. Amer. chem. Soc.*, 1942, **64**, 1342–1346.—A bromine atom which is recoiling from the emission of a γ-ray emitted as a result of neutron capture has about the same probability of reacting with liquid carbon tetrachloride as a bromine atom which has just undergone isomeric change. Practically no reaction occurs in the gas phase. In both the neutron-capture and isomeric-change reactions the presence of products of higher boiling point than CCl_3Br indicates the mechanism of reaction to be more complex than the removal of a single chlorine atom from carbon tetrachloride.

With bromine and tetrachloroethylene reactions in the gas phase, results indicate that probably no reaction takes place following neutron capture, but appreciable reaction follows isomeric transition of the bromine. In the liquid phase the probability of a bromine atom forming a bromo-organic compound following isomeric transition is much greater than either the probability that it will do so as a result of neutron capture or the probability of its reaction with carbon tetrachloride.

The different probabilities of reaction following the two types of activation are discussed. The Franck and Rabinowitsch "cage" hypothesis (*Trans. Faraday Soc.*, 1934, **30**, 120) is supported by the difference in probability observed between reactions in liquid and gas phases.

E. H. W.

868. Hydrogen Fluoride as a Condensing Reagent. XVI. Reactions of Carbon Monoxide. J. H. Simons and A. C. Werner. *J. Amer. chem. Soc.*, 1942, **64**, 1356–1357.—Conditions are described by which carbon monoxide reacts in the presence of hydrogen fluoride with *iso*propyl chloride or *n*-propyl alcohol, but not *iso*propyl alcohol, giving *iso*butyric acid. In the absence of either water or methanol, *iso*propyl chloride did not yield the acid. The results are discussed and a mechanism for the reactions is proposed.

E. H. W.

869. Higher Hydrocarbons. I. Seven Alkyl-Substituted Docosanes. F. C. Whitmore, L. H. Sutherland, and J. N. Cosby. *J. Amer. chem. Soc.*, 1942, **64**, 1360–1364.—The syntheses of 11-*n*-butyl-, 9-*n*-butyl-, 7-*n*-butyl-, 5-*n*-butyl-, 7-*n*-hexyl, 9-*n*-octyl-, and 11-*n*-decyldocosanes are described. M.pt., b.pt. at 1·0 mm., n_D^{20}, d_4^{20}, molecular refraction, and viscosity at 20° C. are reported for each hydrocarbon, together with yields and properties for seventeen intermediates. Special emphasis is laid on the need for obtaining pure compounds, and the general problem of purity is discussed.

E. H. W.

870. Heats of Catalytic Hydrogenation of Solution. I. Apparatus, Technique, and the Heats of Hydrogenation of Certain Pairs of Stereoisomers. R. B. Williams. *J. Amer. chem. Soc.*, 1942, **64**, 1395–1404.—Measurement of the heats of catalytic hydrogenation in solution at room temperature are reported. The catalysts used were $PtO_2.H_2O$ or PdO, glacial acetic acid was the solvent. The apparatus and technique employed are described. To check the accuracy of the results, the heat of hydrogenation of *n*-heptane-1 in the gas phase at 355° K. was derived from the figure obtained at 302° K.

in glacial acetic acid solution, Kistiakowsky's figure obtained directly in the gas phase was in excellent agreement. Heats of catalytic hydrogenation in solution of the following substances are reported: 1 : 4-dihydronaphthalene, 1 : 2-dihydronaphthalene methyl *cis*-cinnamate, methyl *trans*-cinnamate, *i*-stilbene, stilbene, diethyl maleate, diethyl fumarate, 1 : 4-diphenylbutadiene. The results show agreement with the rules put forward by Kistiakowsky for the effect of substituents on the heat of hydrogenation of the ethylenic double bond. Values for the increase in stability due to conjugation of certain of the compounds are given, and the heats of isomerization of the pairs of stereoisomers are considered. The heat of complete hydrogenation of 1 : 2-dihydronaphthalene is shown to be greater than that for indene (the corresponding 5-membered ring compound). This result also agrees with previous reports by Kistiakowsky and co-workers on similar pairs of compounds. E. H. W.

871. Studies in Gaseous Hydrogenation and Polymerization Reactions. H. B. Burnham and R. N. Pease. *J. Amer. chem. Soc.*, 1942, **64**, 1404–1410.—Small initial additions of nitric oxide are shown to inhibit the polymerization of ethylene and acetylene, as well as the hydrogenation of ethylene. A chain mechanism is proposed for these reactions, and it is also suggested that the nitric oxide acts by combining with the free radicals or atoms, and thus effectively prevents their further participation in the chain reaction. Nitric oxide did not inhibit either the hydrogenation or polymerization of propylene; instead, a slight acceleration of the reactions was observed. This catalytic effect of nitric oxide neither favours nor denies the possibility of a chain mechanism in the propylene reactions studied. E. H. W.

872. The Mechanism of the Catalytic Reduction of some Carbonyl Compounds. L. C. Anderson and N. W. MacNaughton. *J. Amer. chem. Soc.*, 1942, **64**, 1456–1459.—A mixture of hydrogen (80 parts) and deuterium (20 parts) has been used in the catalytic reduction of *n*-butyraldehyde, acetaldehyde, acetone, diethyl ketone, and methyl ethyl ketone. The mechanisms of the reactions were studied by examination of the Raman spectra of the reduction products, these latter were oxidized, and the Raman spectra of the products determined.

In the presence of nickel, platinum, and copper chromite, reduction occurred at low temperatures through addition of hydrogen to the carbonyl group. At elevated temperatures, acetone and butyraldehyde were reduced to a considerable extent through the addition of hydrogen to the carbon–carbon double bond of the enol form.

It has been shown that in the presence of Raney nickel there was preferential addition of the HD molecule to the carbonyl group, forming CD and OH bonds. With *iso*-propyl and *n*-butyl alcohols in the presence of nickel at 25° C. or platinum up to 250° C. deuterium was exchanged for the hydroxyl hydrogen, but with nickel or copper chromite catalysts at 250° C. exchange took place on the hydrogen of both the carbinol carbon atom and that of the adjacent carbon atom. In the latter exchanges the results were taken as evidence that dehydrogenation, enolization, and hydrogenation reactions were all involved. E. H. W.

873. Catalytic Hydrogenation of Heptaldehyde in Vapour Phase. T. J. Suen and S. Fan. *J. Amer. chem. Soc.*, 1942, **64**, 1460–1462.—The experimental procedure and identification of products are reported for the hydrogenation of heptaldehyde in the vapour phase under atmospheric pressure in the presence of a nickel catalyst.

The main product was *n*-hexane, together with some *n*-heptyl alcohol. Carbon monoxide formed in the degradation reaction was partly reduced to methane. E. H. W.

874. The Ultra-violet Absorption Spectra of Coronene. Note by J. W. Patterson. *J. Amer. chem. Soc.*, 1942, **64**, 1485–1486.—Coronene is the simplest hydrocarbon in which benzene rings completely surround a central aromatic nucleus. The position and intensities of the bands and the ultra-violet absorption spectra are recorded. E. H. W.

875. The Electron Diffraction Investigation of Propargyl Chloride, Bromide, and Iodide. L. Pauling, W. Gordy, and J. H. Saylor. *J. Amer. chem. Soc.*, 1942, **64**, 1753–1756.—The interatomic distances of the propargyl halides have been determined from electron

diffraction measurements. The distances calculated were (assuming C = C, 1·20 Å.): C–C, 1·47 ± 0·02 Å.; C–Cl, 1·82 ± 0·02 Å; C–Br, 1·95 ± 0·02 Å.; C–I 2·13 ± 0·03 Å. and the angles C–C–Cl, 111 ± 2°, C–C–Br 112 ± 2°, C–C–I 111 ± 3°. As with methylacetylene (*J. Amer. chem. Soc.*, 1939, **61**, 927), the C–C distance is less than normal; but the carbon halogen bond distances are somewhat larger than usual. E. H. W.

876. The Reduction of Unsaturated Hydrocarbons at the Dropping Mercury Electrode. I. Phenyl-substituted Olefins and Acetylenes. H. A. Laitinen and S. Wawzonek. *J. Amer. chem. Soc.*, 1942, **64**, 1765–1768.—This paper presents a polarographic study of a series of phenyl-substituted olefins and acetylenes. A solution of 75% dioxane and 25% water was used with tetrabutylammonium iodide as supporting electrolyte. Substances investigated included stilbene, triphenylmethane, diphenylbutadiene heptyne-1, *o*-allylanisole, phenylacetylene, styrene, 1 : 1-diphenylethylene β-methylstyrene, tetraphenylethylene, and diphenylacetylene. Half-wave potentials and diffusion-current constants determined are tabulated. All the hydrocarbons investigated showed a well-defined reduction wave. The half-wave potentials were generally independent of pH. The diffusion current was proportional to the hydrocarbon concentration in every case, and the polarographic method was claimed to be useful for the detection and determination of these hydrocarbons in the absence of more readily reducible substances. Further uses for the method were also claimed. A mechanism of the reduction was proposed. The diffusion coefficients of the hydrocarbons have been calculated from diffusion-current data. E. H. W.

877. The Formation of *cyclo*Propanes from Monohalides. III. Action of Sodium Alkyls on Aliphatic Chlorides. Relation to the Wurtz Reaction. F. C. Whitmore and H. D. Zook. *J. Amer. chem. Soc.*, 1942, **64**, 1783–1785.—The reaction of sodium with excess mercury diethyl in *n*-pentane solution at 25° C. gave an 80% yield of sodium ethyl. To this reaction mixture *n*-hexylchloride was added at −10° C. to 0° C., giving a yield of 40% *n*-octane, 46% yield of 1-hexene, and 52% yield of ethane, together with a small amount (2%) of ethylene. An 88% yield of sodium *n*-propyl was obtained from sodium and excess mercury di-*n*-propyl in *n*-octane solution. The sodium *n*-propyl reacted with neopentyl chloride at 50–60° C., giving a 75% yield of 1 : 1-dimethyl*cyclo*propane, 4% yield of 2 : 2-dimethylhexane, and 70% yield of propane, together with 5% yield of propene, the latter probably coming from the sodium alkyl. The chief reaction is the sodium alkyl acting as a hydrocarbo base and splitting out hydrogen chloride from an alkyl chloride. The base strength of the sodium alkyl is seen from the fact that neopentyl chloride does not react with alcoholic potash in a sealed tube at 100° C. for 20 hrs. The possible relationship of these results to the mechanism of the Wurtz reaction is discussed. E. H. W.

878. Higher Hydrocarbons. II. Five 11-Substituted Heneicosanes. F. C. Whitmore, J. N. Cosby, W. S. Sloatman, and D. G. Clark. *J. Amer. chem. Soc.*, 1942, **64**, 1801–1803.—Continuing previous work which reported the preparation and properties of seven alkyl-substituted docosanes (*J. Amer. chem. Soc.*, 1942, **64**, 1360), the present paper describes the synthesis and properties of five heneicosanes with different type substituents in the 11-position. Keeping the paraffin chain constant and changing the type of substituent (as now reported) had a much greater influence on the properties than either moving a side-chain or altering the molecular weight.

Particular care was taken to obtain pure compounds. In the compounds prepared the substituents were: *n*-amyl-, (3-pentyl)-, *cyclo*pentyl-, phenyl-, and *cyclo*hexyl-, in addition 11-phenyl-10-heneicosene was prepared. The constants given are m.pt., b.pt. (at 1·0 mm.), n_D^{20}, d_4^{20}, molecular refraction, and viscosity at 20° C. in cps. E. H. W.

879. The Compressibility of Liquid *n*-Octane. W. A. Felsing and G. M. Watson. *J. Amer. chem. Soc.*, 1942, **64**, 1822–1823.—The compressibility of liquid *n*-octane has been determined between 100° C. and 275° C. in 25° steps, and for pressures ranging from 5 to 300 atmospheres.

The specific volumes as functions of pressure are given, together with the specific volumes of liquid *n*-octane in contact with its vapour over the same range of temperature as the compressibilities. E. H. W.

880. The Dissociation of Hexa-arylethanes. XII. The Effect of Naphthyl and Biphenyl Groups. C. S. Marvel, J. W. Shackleton, C. M. Himel, and J. Whitson. *J. Amer. chem. Soc.*, 1942, **64**, 1824–1825.—Measurement by the magnetic susceptibility method of several hexaphenylethanes combining α-naphthyl, β-naphthyl, and *p*-biphenyl radicals is reported. The dissociations were all calculated at 0·1 molar concentrations by the mass law. The results obtained are lower than the reports in the older literature. α-Naphthyl groups caused a much higher dissociation than β-naphthyl groups, showing again the importance of the steric factor. E. H. W.

881. Tri-*o*-tolylmethane. P. D. Bartlett and J. E. Jones. *J. Amer. chem. Soc.*, 1942, **64**, 1837–1842.—A preparation of tri-*o*-tolylmethane is described. With phenyl*iso*propyl potassium the central metalation product potassium tri-*o*-tolylmethide was not formed, but instead, a tripotassium derivative which, by carbonation, forms the potassium salt of triphenylmethane 2 : 2′ : 2″-triacetic acid. This is in contrast to the behaviour of the related compounds, phenyldi-*o*-, diphenyl-*o*-, and tri-*p*-tolylmethane, which under the same conditions all yield monopotassium derivatives that form triarylacetic acids by carbonation. Various explanations for the relative inertness of the central carbon atom of tri-*o*-tolylmethane are discussed. E. H. W.

882. The Ternary Systems Involving *cyclo*Hexane, Water, and *iso*Propyl and Normal Propyl Alcohols. E. R. Washburn, C. E. Brockway, C. L. Graham, and P. Deming. *J. Amer. chem. Soc.*, 1942, **64**, 1886–1888.—Tabulated and graphical results are presented for the solubility relationships at 25° C. of the ternary systems containing water, *cyclo*hexane, and *iso*propyl alcohol, and at 25° C. and 35° C. for the ternary system containing water, *cyclo*hexane, and *n*-propyl alcohol. E. H. W.

883. The Viscosity of *cis*- and *trans*-Decahydronaphthalene. W. F. Seyer and J. D. Leslie. *J. Amer. chem. Soc.*, 1942, **64**, 1912–1915.—A detailed description is given of the determinations of the viscosities in centipoises of *cis*- and *trans*-decahydronaphthalene at 10° intervals from −30° C. to 180° C. The viscometers were modifications of the Ostwald type, made in accordance with British Standards Specification No. 188–1937, and were calibrated with pure water. Curves for log η against $\frac{1}{T}$, although not linear, were smooth, but with the *cis*-isomer a deviation began at 110° C. Physical constants for *cis*- and *trans*-isomers of several other hydrocarbons are given, and in each case the *cis*-isomer has a higher boiling point, specific gravity, viscosity, and E_{vis} (the average molar activation energy for viscous flow).

A suggestion is made to explain the high values of η and E_{vis} of decahydronaphthalene and the effect of *cis*- and *trans*-isomerism on these. E. H. W.

884. The Hydration of *iso*Butene in Dilute Nitric Acid. G. R. Lucas and L. P. Hammett. *J. Amer. chem. Soc.*, 1942, **64**, 1938–1940.—The results of an investigation of the reaction between *t*.-butyl chloride and mercuric nitrate in various dioxane–water mixtures are given. In a semi-quantitative study of the hydration of *iso*butene in dilute nitric acid it was shown that the rate of disappearance of *iso*butene decreased rapidly when increasing proportions of dioxane were present. The results indicated that *t*.-butyl nitrate was not an intermediate in this reaction. Reasons for the increase in the rate of hydration on addition of nitrate ions are discussed. E. H. W.

885. Identification of Alcohols and Alkyl Hydrogen Sulphates with *S*-Benzylthiuronium Chloride. Note by R. S. Bair and C. M. Suter. *J. Amer. chem. Soc.*, 1942, **64**, 1978.—*S*-Benzylthiuronium chloride, produced by the action of benzyl chloride with urea, is shown to be a useful reagent for preparation of derivatives of alcohols and alkyl hydrogen sulphates. Alcohols are converted first into alkyl hydrogen sulphates by warming in dioxane solution with chlorosulphonic acid. Melting points and a description of the preparation of a number of derivatives are given. E. H. W.

886. The Dehydration of 1 : 5-Hexadiene-3-ol to 1 : 3 : 5-Hexatriene and 1 : 3-*cyclo*Hexadiene. Note by L. W. Butz. *J. Amer. chem. Soc.*, 1942, **64**, 1978–1979.—

The presence of 1 : 3-*cyclo*hexadiene in the hydrocarbons obtained by dehydrating 4 : 5-hexadiene-3-ol is confirmed, and reasons for its presence are discussed. E. H. W.

887. The Dipole Moments of *cyclo*Hexanol and *cyclo*Hexanone in Dioxane. Note by I. F. Halverstadt and W. D. Kumler. *J. Amer. chem. Soc.*, 1942, **64**, 1982.—Measurements of the dipole moments of *cyclo*hexanol and *cyclo*hexanone in dioxane solution at 25° C. Evidence from the results showed that the compounds were not associated in dioxane solution. E. H. W.

888. The Ignition of Methane by Hot Wires. W. Davies. *Fuel*, 1943, **22**, 72.—Methane and air in explosive mixtures cannot be ignited by direct transmission of heat from a thin gold or platinum wire. Ignition occurs when the wire fuses, and it is then caused by the arc, and not by the heat of the wire. The m.pt. of platinum is 750° C. higher than that of gold, but ignition occurs more readily when the gold wire fuses. This is due to the catalytic action of the platinum wire, which renders the gas in the neighbourhood of the wire non-inflammable prior to the attainment of the fusion point. A contributory factor is the higher current flowing in a gold wire, diameter for diameter, which is required to cause fusion compared with a platinum wire. The breaking of this higher current causes a more powerful arc. J. W. H.

889.* Thermodynamics of the Liquid State. K. M. Watson. *Industr. Engng Chem.*, 1943, **35** (4), 398.—By means of an application of the theorem of corresponding states it is shown that it is possible to calculate, from a knowledge of the b.pt., critical temperature, critical pressure, and the liquid density at some one temperature, the following thermodynamic properties of liquids: thermal expansion and compressibility, pressure correction to enthalpy and entropy, pressure correction to heat capacity at constant pressure, latent heat, difference in heat capacity between a saturated liquid and an ideal gas, and the difference in heat capacity between a saturated liquid and heat capacity at constant pressure. Calculations of this type, like all applications of the theorem of corresponding states, do not give a rigorously correct answer, but the information obtained is usually sufficiently accurate for process design problems and is of great value in the correlation of fragmentary experimental data. J. W. H.

890.* Effect of Column Hold-up on Batch Rectification. E. Edgeworth-Johnstone. *Industr. Engng Chem.*, 1943, **35** (4), 407.—Previous workers have given methods of calculating the effect of column hold-up on the degree of separation at constant reflux. To conserve heat and time, it is common practice to start a distillation at a low reflux ratio and to increase it progressively as the cutting point is reached to maintain constant product composition. Equations are given which enable the effect of hold-up under the foregoing conditions to be calculated precisely for binary mixtures and approximately for complex mixtures. Examples are worked out illustrating the solution of the equations given for five-component mixtures. J. W. H.

891.* Effect of Temperature on Liquid–Liquid Equilibrium. S. W. Briggs and E. W. Comings. *Industr. Engng Chem.*, 1943, **35** (4), 411.—The experimental technique employed for the determination of the phase diagrams of the systems benzene–acetone–water and docosane–1 : 6-diphenylhexane–furfural is described. The equilibrium diagrams at a series of temperatures are given, and the values of these data in computing continuous extraction conditions with and without a temperature gradient are discussed. J. W. H.

892.* Design Calculations for Plate Columns. E. M. Baker and R. A. Lindsay. *Industr. Engng Chem.*, 1943, **35** (4), 418.—The application of the McCabe and Thiele method for the solution of a theoretical plate problem necessitates an assumption of constant molal overflow. This paper presents a method, based on enthalpy, for the calculation of theoretical plates when the molal overflow is not constant. The cases dealt with are: separation of one feed with no entrainment and separation of one feed with entrainment. Each of the cases is illustrated by an example. J. W. H.

893.* Correlation of Physical Properties of Paraffin Hydrocarbons. A. W. Francis. *Industr. Engng Chem.*, 1943, **35** (4), 442.—The boiling points of all the possible octanes (17), nonanes (34), decanes (74), and undecanes (159) have been calculated from the same properties of the next lower paraffins (precursors). The basis of the method used is the effect of the introduction of a methyl group in one of twenty-two possible ways. For each of these ways there is an increment in the physical property which is a simple ratio of the increment which is realized on the addition of a methyl group to the straight-chain hydrocarbon precursor. Good agreement is obtained between separate calculations of the same physical property by introducing the methyl group in a different manner. Where available it is shown that the calculated values are in agreement with those obtained by experiment, although in some cases there is strong evidence that a revision of the experimentally determined values may be required. Paraffin isomers with two branches on non-adjacent carbon atoms have almost identical boiling points. J. W. H.

894.* Electron Microscopy in Chemistry. Vladmir K. Zworykin. *Industr. Engng Chem.*, 1943, **35** (4), 450.—The applications of electron microscopy to chemistry are discussed and illustrated by micrographs of various materials, including carbon black, polyvinyl chloride, and polystyrene. Descriptions are given of the various techniques employed, such as stereomicrophotography, diffraction patterns, surface replicas, and scanning. J. W. H.

895.* Ternary Liquid and Binary Vapor-Liquid Systems. C. E. Dryden *Industr. Engng Chem.*, 1943, **35** (4), 492.—A method of correlating the distribution of the components in a ternary liquid system is described, and a method of applying this data to successive theoretical stages in an extraction system is given. Ten different systems are shown to conform to the hyperbolic equation used for making the correlation, and among these the ternary system methyl*cyclo*hexane–aniline–*n*-heptane occurs. J. W. H.

896.* Graphical Interconversions for Multicomponent Systems. J. D. Leslie. *Industr. Engng Chem.*, 1943, **35** (4), 495.—The method of Sun and Silverman for making interconversions of weight, volume, and molar compositions has been extended to multiple systems. J. W. H.

897.* Interconversions of Polycomponent Compositions by Graphical Methods. K. H. Sun and A. Silverman. *Industr. Engng Chem.*, 1943, **35** (4), 497.—Simple graphical methods are described for the interconversion of weight, volume, and mole fraction for polycomponent systems. J. W. H.

898. The Viscosity of Dilute Solutions of Long-Chain Molecules. M. L. Huggins. *J. appl. Phys.*, 1943, **14** (5), 246.—The effect of the solvent on the viscosity of dilute solutions of long-chain molecules is treated mathematically. Experimental data are given for solutions of polybutene and polystyrene in a number of hydrocarbon and other solvents. From these data it is shown that the values of η^{sp}/c for a solution of a given polymer are symbatic with the proportion of a poor solvent which must be added to cause precipitation. J. W. H.

899.* Prediction of Reaction Rates. F. Daniels. *Industr. Engng Chem.*, 1943, **35** (5), 504.—Examination of thirty unimolecular gas reactions shows that a simple Arrhenius equation can be applied. Empirical and theoretical rules for predicting reaction rates are examined and recommendations made. The practical application of reaction-rate equations is discussed. J. W. H.

900.* Organic Reactions. H. Eyring, H. M. Hulbart, and R. A. Harman. *Industr. Engng Chem.*, 1943, **35** (5), 511.—The basic theory of the thermodynamics of reaction rate are given, and the types of activated complex which govern the reaction rate are discussed. The theory of the following types of reaction are reviewed: intramolecular rearrangement, double bond reactions, and heterogeneous reactions. J. W. H.

901.* Principles of Reactor Design for Gas-Solid Interface Reactions. D. M. Hurt. *Industr. Engng Chem.*, 1943, **35** (5), 522.—A method of correlating the performance of small- and large-scale reactors in gas-solid interface reactions is given. This new method involves the concept of H.R.U. (height of overall reaction unit) and H.C.U. (height of a catalytic or surface reaction unit). These terms are used in conjunction with the conventional gas film H.T.U. as a measure of mass transfer rate. Experimental data are given correlating heat and mass transfer rates with the Reynolds' number.
J. W. H.

902.* Solid Catalysts and Reaction Rates. O. A. Hougen and K. M. Watson. *Industr. Engng Chem.*, 1943, **35** (5), 529.—From the activated adsorption theory reaction-rate equations are developed for chemical reactions catalysed by solids. The derivation of the basic equation is given, and from this a simplified equation is derived for monomolecular surface reactions. Equations are also derived for bimolecular–monomolecular and bimolecular–bimolecular reactions. Quantitative expressions are proposed for the effects of adsorption, dissociation, catalyst activity, particle size, flow conditions, poisons, diluents, temperature, pressure, and concentration. Methods of integrating these equations for the design of commercial reactors are given. J. W. H.

903.* Conduction, Convection, and Heat Release in Catalytic Converters. R. H. Wilhelm, W. C. Johnson, and F. S. Acton. *Industr. Engng Chem.*, 1943, **35** (5), 562.—Solutions are presented for the thermal equations involving the rate of heat generation in cylindrical and slab-shaped catalyst beds, the rate of removal of heat by convection between solid and gas, and its removal by conduction through the catalyst and gas in a direction perpendicular to the direction of flow of the gas stream. To simplify the use of the equations, the functions are plotted in dimensionless form, and by the use of these graphs a practical problem is worked out. J. W. H.

904.* Thermodynamic Properties of Propane. W. N. Stearns and E. J. George. *Industr. Engng Chem.*, 1943, **35** (5), 602.—From the physical properties of propane determined by various workers, a wide-range temperature–entropy and Mollier diagram has been constructed. The method employed for correlating the various data is described. J. W. H.

905.* Composition of Vapours from Boiling Binary Solutions. D. Othmer. *Industr. Engng Chem.*, 1943, **35** (5), 614.—A detailed description is given of an all-glass apparatus for the determination of the vapour–liquid equilibria of binary mixtures at pressures from 1 mm. Hg to atmospheric pressure. Vapour–liquid equilibria data are given for twenty-six binary systems. These mixtures include data on the systems acetic acid–toluene, acetic acid–xylene, acetone-benzene, acetaldehyde-benzene and acetaldehyde-toluene. J. W. H.

906. The Fundamental Problem of the Theory of Viscous Fluids. H. Putman. *J. appl. Phys.*, May 1943, **14** (5), 244–245.—An hydrodynamic approach based on the Navier–Stokes equations, the equation of continuity, and the characteristic equation is suggested for the theory of viscous fluids. The viscosity is assumed constant.
A. H. N.

907. Pressure-Temperature Relations of Petroleum Fractions. W. L. Nelson and W. Haltenberger, Jr. Part I. *Oil Gas J.*, 11.6.42, **41** (5), 38. Part II. *Ibid.*, 18.6.42, **41** (6), 40.—The purpose of the work was to provide data on pressure-temperature relations of moderately wide boiling-range petroleum fractions, and to relate their behaviour to that of narrow boiling-range fractions and pure normal paraffin hydrocarbons, whilst the experimental method adopted consisted of A.S.T.M. and Engler type distillations at different pressures varying from 25 to 760 mm. Hg. Data are presented graphically and in tabular form. The effect of vacuum is to displace the distillation curve vertically by a constant amount. Methods of correlating vapour pressure with temperature are discussed and vapour pressures calculated from the distillation data give approximately straight converging lines on a Cox chart. Change

of pressure alters the boiling points of the petroleum fractions somewhat less than those of the pure paraffins, whilst lines of constant percentage distilled deviate slightly from those of the pure paraffins. The effect of temperature on the change of boiling point with pressure is less pronounced for petroleum fractions than for normal paraffins, the deviations tending to increase with increasing boiling range of the fraction and being greatest for the initial boiling points of low-boiling fractions and for the final boiling points of high-boiling fractions. It is concluded that the differences are not sufficient to affect refinery design computations to a practical extent, and hence the use of the vapour pressures of paraffin hydrocarbons for evaluating the effect of pressure on petroleum fractions need not in most instances be abandoned. J. C.

Analysis and Testing.

908. A New Recording Viscometer for Paint-Consistency Measurements. C. R. Wicker and J. A. Geddes. *A.S.T.M. Bull.*, January 1943, **120**, 11. *Paper Presented before A.S.T.M.*—A new recording viscometer, combining the principles of the modified stormer and the McMichael instruments, is described. A cylindrical container is rotated at constant speed, the liquid within imparting torque to a paddle connected with a spring. A lever arm records the consistency upon a moving chart. Speed of rotation can be varied from 30 to 285 r.p.m. The instrument has been calibrated in grams/200 r.p.m. on the modified stormer, in Krebs units, and in absolute units for viscous liquids. Calibrations are essentially straight-line functions. Using one spring only, the viscometer covers a range of 100–850 stormer grams/200 r.p.m., 60–135 Krebs units, or 5–45 poises, which includes the practical range of paint consistencies. Springs of different characteristics can be used to extend the range.

Stress–strain curves obtained on this instrument are similar to comparable data from modified stormer viscometer data. Unlike the stormer, however, the recording viscometer can be used to obtain a continuous record of consistency. It is therefore possible not only to measure thixotropic and rheopectic paints, but also to follow the thickening of water-sensitive systems, effect of bodying agents, and similar phenomena of interest to the paint chemist. Less skill and experience are required to operate the recording viscometer, and a series of determinations can be made somewhat more rapidly than on the modified stormer. The new viscometer therefore appears suited for control work as well as research consistency measurements. A. H. N.

909.* Equipment for Viscosity Measurement. Part 2. Timing Devices. L. A. Steiner. *Petroleum*, May 1943, **6** (5), 72.—Three types of timing devices may be used for viscosity measurement: spring-driven stop-watches, mains-driven stop-clocks, and timing devices with constant-time base. The error curve of stop-watches is particularly disturbing in calibrations. Precision timing is extremely useful to manufacturers of viscometrical apparatus, for routine calibrations, and for the accurate determination of viscosity. Recent developments in radio technique have enabled the construction of precision-timing devices which are in several respects superior to other types and will find increasing application even when stop-watches are plentiful again. A single unit of this type easily replaces six stop-watches, and is, consequently, economical whenever the number of viscosity determinations is large. For occasional use stop-watches are to be preferred. The characteristics of each class are discussed in detail, sources of errors and methods of control being indicated. A. H. N.

910.* Equipment for Viscosity Measurement. Part 3. Constant-Temperature Baths. L. A. Steiner. *Petroleum*, June 1943, **6** (6), 88.—Temperature-control baths and systems—for viscometric studies—are discussed, with a brief historical sketch. Regulators and relays are studied in some detail. Heat transfer and temperature lag in viscometers are explained with some experimental determinations. A. H. N.

Lubricants and Lubrication.

911.* Deacidification of Transformer Oil by Activated Alumina. J. L. Ferns. *Petroleum*, March 1943, **6** (3), 34.—Results of preliminary experiments carried out by the author, using the percolation method only, are given and reference is made to data

presented before the A.I.E.E. by J. E. Housley. Activated alumina sold for refining purposes consists of about 80% aluminium oxide and 20% of chemically combined water with but few traces of impurities. The method of manufacture in England differs from that employed in the U.S., but the English product is claimed to be superior for the purpose described. General characteristics are tabulated. In view of the affinity which activated alumina possesses for water, the material should be kept dry before use and the oil to be deacidified should be filtered before treatment. Reactivation with a loss of the order of 3% can be achieved by passing hot air through the used alumina in a suitable container, in order to start combustion of the oil content, and then maintaining the temperature of the alumina during the combustion process at 200–250° C. so as to retain the dehydrating properties. The reactivation takes about 3 hrs. and the material should be restored to its original whitish state. A reactivator constructed by the author is described and illustrated.

For the percolation process the popular grade of alumina is the 4/8 mesh, and as the material is free from dust, only a suitable retaining mesh is required. A reasonable depth of bed to avoid passage of liquid without contact with the medium is easily arranged, since, owing to its strength, the alumina will support a considerable weight on a grating, permitting columns of 6 ft. or more to be used if desired, provided the ratio of height to diameter is about 5/1. One of the advantages of activated aluminium is that its deacidifying properties are consistent and its effects are calculable in terms of acidity of the oil, time, and quantity of material. A table shows the approximate weight of activated alumina required to effect a specified improvement in acid value of oil under treatment—*e.g.*, oil having an initial organic acidity equivalent to 2 mgms. KOH/gm. requires treatment with 14 lb. activated alumina per 100 lb. of oil in order to reduce acid value to 0·05 mgm. KOH/gm.

Three methods investigated are: (1) Connecting a container charged with alumina to the transformer and relying upon thermal circulation to create a flow of oil through the container. This method is of advantage when it is not desirable to take the transformer off load or where a preventive treatment is envisaged, for example in the case of a transformer known to suffer from a high-acidification rate. The size of container used will determine the frequency with which the alumina must be changed. (2) Where it is possible to change the oil in the transformer and wash down cores and tubes, it is probably better to treat the oil in a special tank fitted with gauze trays filled with alumina and with arrangements for circulating the oil through the trays. From experiments conducted in a 200-gal. tank it is estimated that a 600-gal. tank charged with 1200 lb. of alumina would give a reasonably quick treatment. Colour is a fair indication of the condition of the oil. (3) Suitable containers filled with alumina may be placed inside the transformer in a safe position near the top of the oil.

Consideration is given to the application of activated alumina to the treatment of switch oils, oils used in oil-filled bushings, turbine oils, etc. R. A. E.

912. Emulsion Lubricants. Anon. *Chem. Tr. J.*, 12.3.43, 251.—This is a summary of a paper in *Oel und Kohle*, No. 9, 1942, and describes the development of emulsion lubricants by a Hamburg Company.

The mineral oil as sold for this purpose apparently contains an emulsifying agent. The user is then instructed how to prepare the emulsion.

It is recommended that the water should not be too hard and should be maintained at 20° C. Equal volumes of water and oil are advised, the water being added to the oil with continuous agitation by hand for small-scale work or a homogenizer of the Hurrell type for large quantities.

The emulsions are of the water-in-oil type and show thixotropic properties. They are stable at temperatures down to −30° C. An example is given of an emulsion suitable for lubricating the cylinders of large gas-engines and compressors.

Other uses for these lubricants are stated to be for shafting bearings, reciprocal compressors and plant driven by compressed air.

The saving of oil in practice is not quite 50%, since about 15% to 20% more emulsion is used than is the case with the non-emulsified oil. D. L. S.

913. Vegetable Oils as Engine Lubricants. Anon. *Gas Oil Pwr*, April 1943, **38** (451), 81.—This paper summarizes results obtained from experiments carried out under the

auspices of the Indian Scientific and Industrial Research Dept. and given in detail in two bulletins, Nos. 18 and 20.

Vegetable oils in general possess better oiliness properties and lower coefficients of friction than mineral oils. They also compare favourably with mineral oils as regards viscosity index.

On the other hand, vegetable oils decompose at lower temperatures and are less stable to oxidation. Oxidation tests were carried out on a number of vegetable oils in the presence of steel balls. Polymerization was found to occur more easily than with petroleum oils, even when stabilizers were added. The development of acidity was more pronounced, and higher Conradson Carbon figures were obtained. Some stabilizers were found to be effective for castor, rape, and groundnut oils, but few were effective for cotton-seed oil. In general these stabilizers were compounds containing more than one benzene nucleus, and amongst these phenols and aromatic amino-compounds were effective.

However, neither the phenolic hydroxyl nor the amino-groups were themselves wholly responsible for these inhibiting properties, since compounds having three phenolic hydroxyl groups such as pyrogallol and *p*-phenylenediamine did not prove to be the best stabilizers. D. L. S.

914. Studies in Lubrication. Part 9. Temperature Behaviour of Journal-Bearing Systems. M. Muskat and F. Morgan. *J. appl. Phys.*, May 1943, **14** (5), 234—. Transient bearing temperature and friction data have been obtained for a journal-bearing system operating under thick-film conditions. The journal speed was varied from 1·5 to 11·0 r.p.s., and tests were made with five different lubricants. Equilibrium values of temperature and friction were determined by exponential extrapolation of data taken over time intervals of 3–6 hrs. By inversion of the Petroff formula, average film temperatures were calculated from the friction data. These were in all cases greater than the directly measured bearing temperatures, although the excess was in general less than 10° F. The equilibrium temperature data for the various lubricants and speeds were correlated on the basis of heat-balance considerations by the formula :

$$\mu N^2 = \text{const}\ (T - T_a)^{1\cdot 36},$$

the film viscosity μ and temperature T referring to equilibrium conditions, T_a denoting the ambient temperature, and N the journal speed. This relation permits the calculation of the equilibrium conditions for a journal-bearing system of the type used here for any lubricant and journal speed. The asymptotic rate of approach to equilibrium was also quantitatively correlated to the final equilibrium conditions. For Gulflube 10 the equilibrium frictional force was found to increase monotonically with the journal speed, the rate of increase quickly tapering off for speeds greater than 4 r.p.s. Its value at 11 r.p.s. is only 0·14 of that to be expected if there were no fall in film viscosity. For Gulflube 30 the friction-force curve rises to a maximum at 3 r.p.s. and then falls slowly for greater speeds. The value at 11 r.p.s. is here only 0·04 of that for a constant-film viscosity system. A. H. N.

915. The Fundamental Problem of the Theory of Viscous Fluids. H. Putman. *J. app. Phys.*, 1943, **14** (5), 244.—The proof of a theorem is given from which, if the distribution of $\overline{\gamma}$, p, and ρ of all viscous particles at time t is known, the distribution at any subsequent time can be calculated. From this, if $d\omega/dt$ is known, then $d(\Delta - \gamma)/dt$ can be calculated. J. W. H.

916.* Catalysis in the Oxidation of Lubricating Oil. R. G. Larsen and F. A. Armfield. *Industr. Engng Chem.*, 1943, **35** (5), 581.—A detailed study has been made of the catalytic effect of metallic iron, copper, and lead, and the naphthenate of these metals on three lubricating oils representative of Pennsylvanian, Midcontinent, and Californian stocks. It is shown that the variation in susceptibility with each of these materials is so great that no specified catalyst can be used in laboratory oxidation tests unless correspondence with engines is first well established. The catalytic effect of engines on oils was also studied by examining the oxidation characteristics of crankcase oils after various periods of service. It was found that these oils were very susceptible to oxidation, and this was found to be due to " crankcase catalysts," which,

on removal by centrifuging, decreased the oxidation susceptibility, and when added to new oils increased the susceptibility. It is shown that this catalytic activity resides in the metallic components, particularly the halides of iron. J. W. H.

Asphalt and Bitumen.

917.* Measurement of the "Firmness" of Asphaltic Bitumens. D. C. Broome. *Petroleum*, July 1942, **5** (7), 122.—Until comparatively recently pitches were tested in some cases by "chewing" or twisting tests which, when carried out by experienced men, gave astonishingly accurate results. However, the personal factor has now been eliminated as far as possible from "firmness" tests on bituminous materials.

It has been suggested that for materials with properties intermediate between those of a true liquid and a Hookean solid firmness can be expressed by the equation: $\psi = S\sigma^{-1}t^k$, where σ is the strain produced by a shearing stress S, t is time, and k varies from zero for an elastic solid to 1 for a true liquid.

The author has found that the values calculated by this equation from experimental test results depend considerably on the conditions of test, and that "firmness" cannot yet be fully expressed in terms of fundamental units.

The A.S.T.M. penetration test appears to be the most valuable routine control test available, and tests with varying loads or temperatures are sometimes useful. However, there may be quite large differences in the effective "firmness" of bitumens which are not reflected in the penetration figures.

If the bitumen is at all plastic some idea of this plasticity may be gathered from the difference between its determined absolute viscosity and the absolute viscosity calculated from the penetration as indicated by Saal and Koens.

It has also been noticed that if a constant stress be applied to a bitumen, the rate of shear does not always remain constant over a period of time. It may increase due to thixotropy or decrease due to work hardening.

Another factor influencing "firmness" tests is the thermal history of the sample.

Allied to the problem of deformation under stress is the question of recovery after removal of stress. The recovery/time curve generally conforms approximately to the equation: $\sigma = aS(1 - e^{-b_1 t/a}) + b_1 St$, where a, b_1 and b_2 are constants and the other symbols have the significance indicated above.

Resistance of the material to tensile stresses is usually measured by ductility at 25° C., but the value of this test would be increased if temperature and rate of strain were varied.

Many other methods of measuring "firmness" not discussed in the paper may be available. D. L. S.

918.* Asphalt–Polybutene Paints. H. C. Evans, D. W. Young, and R. L. Holmes. *Industr. Engng Chem.*, 1943, **35** (4), 481.—The results of weathering tests on a large number of experimental asphalt–polybutene cut-backs, with and without fillers, show that polybutene considerably improved the water resistance. Less than 10% of polybutene is required to produce this effect, the quantity depending on the type and origin of the asphalt. J. W. H.

Special Products.

919. Preparation of 1·3 Butadiene from Petroleum and its Fractions. Translated from the Russian by J. G. Tolpin. Part I. *Oil Gas J.*, 11.2.43, **41** (40), 61.—Results are given of a detailed investigation carried out in the U.S.S.R. on crude oils of different types and their fractions from the point of view of preparation of dienes therefrom. The two main purposes of the research were: (1) to determine conditions for optimum yields of 1 : 3-butadiene from various oil fractions, and (2) to develop a sufficiently precise method of determination of 1 : 3-butadiene formed in the process of pyrolysis.

Baku crude oils, mazut, gasoline Grade 2, four close-cut fractions of Baku gasoline rich in naphthenes, and kerosine and solar oil of Caucasian origin were examined. The apparatus employed is illustrated, and is based on the application of a short heating period and rapid cooling of the reaction products, on account of the known instability of 1 : 3-butadiene at high temperatures. Neither reduction of pressure to any considerable extent nor dilution with inert gas was employed, although these factors are known

to improve yields of butadiene. In determining the most favourable conditions for processing, only temperature and rate of flow were varied. The temperature survey, made at an arbitrary feed rate, showed that yields of butadiene from the gasolines were more susceptible to variation in temperature than yields from the heavier products and crudes. Optimum temperatures ranged from 715° C. for mazut to 750–755° C. for gasoline and its fractions. It was also established that optimum yields from gasoline and its fractions were much greater than from the heavier products.

The effect on yield of varying the rate of flow was then determined for each product at its determined optimum-yield temperature. Again variations were greatest with gasoline; velocities for optimum yields were within the range of 0·4–0·5 mls./min./sq. cm. cross-section of the furnace tube for all products examined.

Under the most suitable conditions of temperature and feed rate the maximum yields of butadiene obtained from the various fractions examined were: mazut 2·5%, solar oil 4%, kerosine 5·5%, gasoline 11%. The 101–103° C. cut from gasoline (largely methyl*cyclo*hexane) gave yields comparable with those from Grade 2 gasoline, but yields from the other three cuts were lower.

The method used for determination of butadiene produced is based on the fact that the hydrocarbon forms only crystalline tetrabromides, one form having a m.pt. of 118° and the other 39° C., whereas with other decomposition products crystalline bromides are either unknown or their formation in considerable quantity is improbable. Decomposition gases after cooling to 0° C. were passed through two brominating vessels in series, before passing to the gasometer. Care was taken to air-blow the apparatus and tar produced in order to displace or extract all butadienes. The liquid mixture of bromides obtained was washed with alkali and water distilled on a water-bath at 10–20 mm. pressure, to remove the bromides boiling under these conditions, and leave a cake of crude tetrabromide. These bromides were decomposed with zinc shavings and alcohol and the liberated gases analysed for olefines and di-olefines by the method of Dobryanskii. Since the regeneration efficiency of pure 1 : 3-butadiene under similar conditions was found by experiment to be 90–95%, a correction factor was applied to the butadiene determined in the regenerated gas, although it is admitted that a certain amount of di-olefines and traces of acetylene are recorded as butadiene by the method employed.

Part II. *Oil Gas J.*, 25.2.43, **41** (42), 76.—More complete details are given of the apparatus employed for the experiments, and analyses of the feed stocks utilized are provided. Results of a series of experiments carried out on each feed stock are presented in a series of tables showing decomposition temperature, rate of flow of oil in mls./min./sq. cm. cross-section of furnace tube, amount of oil decomposed, quantity and melting points of bromides obtained, and yield of 1 : 3-butadiene expressed as percentages of intake. R. A. E.

920.* Vinylidene Chloride Polymers. R. C. Reinhardt. *Industr. Engng Chem.*, 1943, **35** (4), 422.—The polymer reactions, chemical structure, physical properties, and methods of use in fabrication processes are discussed. J. W. H.

921.* Brittle Temperature of Rubber under Variable Stress. A. R. Kemp, F. S. Malm, and G. G. Winspear. *Industr. Engng Chem.*, 1943, **35** (4), 488.—An apparatus and experimental technique are described for determining the point at which rubber and similar materials fracture under variable bending stress when applied at temperatures down to −78° C. Experimental data are given for a large number of different rubber compounds. J. W. H.

922. The Mode of Action of Pyrethrum on the Cockroach. D. N. Roy, S. M. Ghosh, and R. N. Chopra. *Ann. Applied Biology*, May 1943, **30** (1), 42.—The first effect of pyrethrum on cockroaches is to cause intense irritation, followed by destruction of the nerve ganglia resulting in muscular paralysis, followed by death if the dose is heavy enough. Pyrethrin, the active principle, is insoluble in water but soluble in the body-fluid of the cockroach, so that the final result is the same, whether introduced into the body-cavity in the dry form or as a solution in kerosine. When introduced into the tracheal trunks as a solution, it is considered to diffuse through the tracheal wall into the body-cavity, and thence to the nerve ganglia, and when introduced as a powder it

must be dissolved by the tracheal fluid which is concluded to be analogous to the body-fluid, since it has been shown by experiments with chalk, etc., that the action is not one of mechanical blocking. It has also been shown that pyrethrum when swallowed by the cockroach with its food, in a dry or a fluid state, has no effect. C. L. G.

923. **A Versatile Oil-Testing Cell of Novel Design.** T. Hazes. *Rev. Sci. Inst.*, 1943, **14** (5), 141.—A description is given of a simple cell for the routine determination of the electrical properties of insulating oils. This cell is very easily constructed from readily available materials. J. W. H.

924. **Floor Wax.** Anon. *Soap*, June 1943, **19** (6), 113.—The tentative specifications and standard methods of testing of water emulsion floor waxes which have been adopted by the U.S. National Association of Insecticide and Disinfectant Manufacturers are quoted. C. L. G.

925. **Insect Kill. The Action of Insecticides on Insect Tissue.** A. Weed. *Soap*, June 1943, **19** (6), 117.—A brief review is given of experimental work carried out by various investigators on the manner in which insecticides affect insect tissues. Arsenical compounds, which act as stomach as well as contact poisons, have been noted to cause separation of epithelium and connective tissues in the intestines, disintegration or intensified division of red corpuscles, and reduced oxygen consumption. Their effectiveness is related to solubility in the digestive tract, the pH value of the digestive fluids, and the buffering power of the juices and gut contents. Fluorine compounds behave similarly, and also upset the calcium balance and interfere with the catalase and oxidase activities of insect tissue extract. Petroleum oils can cause death by (1) suffocation, by blocking of the respiratory system, (2) destruction of tissue following penetration, and (3) fumigant action. With scale insects the unsaturated compounds are toxic through (2) or (3). Volatile oils pass through the entire body-cavity of scale insects, dissolving the fat and even the entire cellular structure, whereas highly refined kerosine is frequently expelled and has little effect. Heavier refined oils remain in the trachea, causing suffocation, although, in view of the diffusion of oxygen and carbon dioxide through thin films of oil, the toxicity may be due to unsaturated compounds. Gasoline and kerosine vapours are absorbed by insects and slowly given off, toxicity being due to prevention of oxygen absorption by the tissues. It has been found that petroleum oils cause clumping of the chromatin in the nuclei, particularly in the central nervous system, of mosquitoes, this being considered a criterion of asphyxiation. With rotenone, no injury to nerve-tissue has been noted, death being considered due to respiratory failure, although desiccation and starvation are also probable factors. Thiocyanates in general kill insects through injury of nerve-tissue. Pyrethrum causes destruction of the cells of the central nervous system, followed by paralysis. *iso*Butyl undecyleneamide causes dissolution of the chromatin. Pyrin—a mixture of *iso*butyl undecyleneamide and pyrethrum—combines the effect of both constituents, but causes a greater breakdown of the interior ganglionic mass than does pyrethrum alone.

A detailed bibliography is given. C. L. G.

Economics and Statistics.

926. **World Consumption of Petroleum and Its Substitutes During 1942.** W. R. Garfias, R. V. Whetsel, and J. W. Ristori, *Petrol. Tech.*, May 1943, *A.I.M.M.E. Tech. Pub. No.* 1595, 1–3.—Since U.S.A. entered the war virtually all data and information necessary for compiling figures on world petroleum consumption have become unavailable. It is becoming clear that after the war the presentation of a comprehensive idea of the state of the petroleum industry will require the co-operation of statistical bureaux in countries outside U.S.A.

It has been possible to make a rough estimate of the world output of crude petroleum and petroleum substitutes for 1942, and the total is given as 2,208,000,000 brl., a decrease of 171,000,000 brl. below 1941. Crude production is believed to have fallen by about 200,000,000 brl., while the production of substitutes has risen by 28,500,000

brl. (nearly 20%). The U.S.A. crude output declined by about 19,000,000 brl., or under 2%; foreign production is estimated to have fallen by 180,000,000 brl., or more than 20%. Large decreases in output took place in Venezuela and Colombia due to lack of transport.

The 1942 oil output in Japan may have risen to 10,000,000 brl., and the Japanese production from captured fields may have been 23,000,000 brl., thus giving a total some 8,000,000 brl. greater than the peace-time requirements of Japan.

The Axis output in 1942 may have been 112,000,000 brl., 20% more than the 1941 figure. Germany may have produced 46,000,000 brl. of petroleum substitutes. The Axis consumption is estimated at roughly 13,000,000 brl./month during active military operations and 9,000,000 brl./month between campaigns. The increase in substitutes may indicate the ineffectiveness of aerial attacks on German synthetic plants or that the location of all these widely distributed plants is not known. G. D. H.

927. Capital Flow and Capital Formation in the Petroleum Industry, 1934–1941. J. W. Pogue and F. G. Coqueron. *Petrol. Tech.*, May 1943, *A.I.M.M.E. Tech. Pub. No.* 1597, 1–12.—Analysis of the financial data covering a representative group of thirty oil companies for a period of eight pre-war years, aside from constituting an economic and accounting record, leads to several broad conclusions: (1) The petroleum industry generated the capital necessary for its maintenance and expansion, thus constituting a self-reliant industry. (2) The net increase in debt was very modest and the existing ratio of debt to other forms of capital is conservative. (3) Investments in fixed capital assets increased in importance between 1934 and 1941, and current assets became less important in relationship to borrowed and invested capital. (4) Nearly two-thirds of the capital invested went into the producing branch of the industry, indicating the high cost of replacing and increasing crude-oil reserves. (5) The efficiency of capital utilization is indicated by the fact that the thirty oil companies under review increased their crude-oil production by 55% and their runs to stills by 52% between 1934 and 1941 as compared with a net expansion of 23% in gross fixed capital assets. (6) The gross investment in fixed capital assets of thirty oil companies on 31st Dec., 1941, was 10,173 million dollars, divided as follows: production 49·0%; transportation, 15·2%; refining, 18·7%; marketing 15·1%; and all other, 2·0%. (7) The flow of funds exhibited cyclical variations, expenditures for capital investments fluctuating with changes in the price of crude oil. (8) The return on invested capital for twenty-nine oil companies for eight years averaged 6·4% against 8·7% for a group of over 1100 manufacturing companies. (9) The consolidated statements here submitted point to an oil economy functioning soundly and effectively.

Data are presented in thirteen tables and five figures. G. D. H.

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Geology and Development.

928.* More Wildcats Drilled in May, but Results Poor. L. J. Logan. *Oil Wkly*, 21.6.43, **110** (3), 11.—Wildcatting expanded materially in May, and discoveries increased above those for several preceding months, but the overall results were disappointing because the new producing areas were predominantly rated mediocre or poor. 65 wildcats or semi-wildcats succeeded against 46 and 43 in April and March respectively, but less new oil was found in May than in April or March. Only two of the

May discoveries (new deep Ordovician pay field of Winkler County, West Texas, and the new pay (Rodessa) of the New Hope field, Franklin County, East Texas, which was recently opened in the deeper Travis Peak sand) seem likely to have reserves of 20,000,000 brl. or more.

345 wildcats and semi-wildcats were completed in May, against 250 in April and 248 in March. The May discoveries may add 40,000,000–100,000,000 brl. to the U.S. reserves, whereas 60,000,000–150,000,000 brl. are ascribed to the discoveries in each of the months March and April.

The current oil production is about 127,000,000 brl./month. There appears to be little chance of 4500 wildcats being drilled in 1943.

During May Illinois had one small new field, seven substantial extensions, and four new pays; Kansas had seven new fields and one new pay; Oklahoma had one new pay, two gas-fields, and one gas-field extension.

The Winkler County Ordovician strike is on a narrow north–south Ellenburger structure outlined by geophysics. The first Lower Permian production of the eastern side of the Permian basin has been found at Vincent, West Texas.

Tables give data about the wildcat completions by States for May and for the first five months of 1943, with some 1942 figures for comparison; and a list of the successful wildcats in May 1943, with name, location, completion date, depth, completion horizon, producing formation, initial production, structure, and method of discovery.

G. D. H.

929.* Canadian Oil Production Down in First Quarter. Anon. *Oil Wkly*, 28.6.43, **110** (4), 55.—During the first three months of 1943 Canada produced 2,501,867 brl. of crude and natural gasoline against 2,644,684 brl. in the same period of 1942. Alberta gave 2,427,455 brl. in the first quarter of 1943, of which 2,269,578 brl. came from Turner Valley. In the same quarter of 1942 Alberta produced 2,604,299 brl., and Turner Valley 2,473,928 brl. The Northwest Territories yielded 38,037 brl. of oil in the first quarter of 1943, and Ontario 29,749 brl., the corresponding figures for the first quarter of 1942 being 129 brl. and 35,108 brl. G. D. H.

930.* Mexican Crude Production Running Below Last Year. Anon. *Oil Wkly*, 28.6.43, **110** (4), 55.—The crude-oil output of Petroleos Mexicanos, the Mexican Government oil company, is below the 1942 level. The March production for the southern zone is slightly above that for February. In the thirty days ending 19th April the northern area gave 2,203,122 brl., the bulk of it from Poza Rica. G. D. H.

931.* New Oil-Field Opened in Southern Alberta. Anon. *Oil Wkly*, 28.6.43, **110** (4), 55.—Oil production has been obtained in the Vauxhall field, Alberta, 50 ml. north-east of Lethbridge.

Imperial-Armelgra No. 1 well is giving 35 brl./day by pumping. G. D. H.

932.* Oil Supply Near Arctic Circle Made Available by Army. Anon. *Oil Wkly*, 5.7.43, **110** (5), 50.—In 1920 a single well found oil on the Mackenzie River, near Fort Norman, and the oil was refined and used locally. In 1942 it was realized that military installations in Canada and Alaska could be supplied with oil from this area, if the products could be made and transported to them. Wells have been drilled, a pipe-line is being laid, and a refinery will be built in spite of great difficulties. Sufficient oil is understood to have been obtained to meet the original specified requirements.

G. D. H.

933.* Whence Cometh Our Future Oil? Anon. *Oil Wkly*, 12.7.43, **110** (6), 22.—Recent sharp rises in U.S. oil production indicate that in less than a year the surplus production capacity will have been fully absorbed.

There has been a sharp decline in the quantity of new oil found annually during the past four years. Various surveys have shown that the rate of finding oil has fallen in spite of an increase in wildcat footage and a continuation of a high rate of drilling wildcat wells. The new fields found have been smaller in size than those discovered in preceding years.

Denison believes that deeper drilling on known producing structural traps offers the quickest method of maintaining daily productive capacity. In many areas 5000 ft. or more remain to be tested below recent producing traps, and while a great many of these structures will require wells over 10,000 ft. deep, none need exceed 15,000 ft. In such drilling, materials may be conserved, the location of the structure is known, and geophysical work and much geological work are unnecessary.

Levorsen maintains that many layers of geology, each with its own wedge-belts of porosity, facies and lithological changes, structural history, and oil and gas geology, remain to be explored. He notes that some thousands of miles of wedge-belts of porosity remain to be explored. Krynine and Levorsen believe that more detailed geological studies and re-examination of existing data will prove valuable in locating stratigraphic traps at reasonable cost. Geologists have become buried in routine service work, which prevents the paying of adequate attention to the discovery of new fields. The oil industry's economic framework does not encourage the geologist to fulfil this most important function.

Pratt states that mental outlook is a greater obstacle to oil-finding than the physical conditions within the earth's crust. Too much attention is paid to re-working limited unknown oil-bearing areas, too little to expanding the search.

Knowlton advocates improved secondary recovery work as a means of increasing production, apart from exploratory drilling. Torrey estimates that the U.S. oil reserves could be increased by more than 4,000,000,000 brl. by wide application of suitable secondary recovery technique. Low oil prices seem to be a retarding factor in secondary recovery work. G. D. H.

934.* Well Completion Rate Up in June ; Total Down 21·7% for Year. Anon. *Oil Wkly*, 12.7.43, **110** (6), 69.—During the four weeks ended 26th June the completions averaged 367 per week, the highest rate in 1943, but 6% below the June 1942 figure. In the first half of 1943 the completions (8732) were 21% below the total for the same period of 1942. So far this year Californian completions are nearly double those for the first half of 1942, those of Colorado and Kentucky double, and those of Wyoming, Montana, and Arkansas have increased by 59%, 28%, and 13%, respectively.

This year Texas completions are 41% below the figures for the first half of 1942. Other decreases are: Illinois 7%, Indiana 40%, Louisiana 42%, Michigan 30%, Mississippi 72%, New Mexico 39%, Ohio 23%, Oklahoma 15%, Pennsylvania 33%, and West Virginia 18%.

Tables give data on completions by States and districts for June 1943, and for the first half of 1943, with comparative figures for other months and for 1942. G. D. H.

935.* More Rumanian Oil for Germany Sought ; but Concern Felt for Declining Output. Anon. *Oil Wkly*, 12.7.43, **110** (6), 70.—The Germans have been collaborating in expanding oil-transporting facilities in Rumania, both pipe-line and rail, and a canal from Constanta to Bucharest is planned.

Rumanian oil constitutes about one-third of the oil available to the Axis in Europe, and the exports to Germany form about a fifth of the total oil consumption of Axis-controlled Europe. The Rumanian output in 1942 is estimated at 34,000,000 brl., a decline of 10% on the 1941 output, and little more than half of the 1936 output. The decline in Rumanian oil production was begun by governmental policy which discouraged development, and in recent years it has been accelerated by excessive production rates in developed fields.

In 1941 the Buzau and Bacau districts gave about 250,000 brl. The Dambovitsa district was at its peak in 1936, but by 1941 had declined to about a third of the peak figure. The Prahova district's peak production was in 1939, but it suffered a much smaller decline to 1941. G. D. H.

936.* Crude Production Rising in North-Western Canada. Anon. *Oil Wkly*, 12.7.43, **110** (6), 71.—In April 1943 the North-west Territories produced 19,692 brl. of oil, compared with 2 brl. in April 1942, and the total for the first four months of 1943 is 57,729 brl.

During April 1943 Canada produced 837,072 brl., and for the first four months of 1943 the total is 3,338,939 brl. of 35 gal. Of this last total Turner Valley yielded 3,022,566 brl. G. D. H.

937.* Rate of Wildcatting Slows Down During June. L. J. Logan. *Oil Wkly*, 19.7.43, **110** (7), 13–16.—Although fewer wildcats were completed and fewer discoveries made in June than in May, the total oil discovered may have been as much as in May, and some of the discoveries may develop into major reserves. 50–100 million barrels of reserves may have been found in June, but March and April each had 60–150 million barrels of possible reserves. Even the more optimistic figure for June is 20 million barrels below the month's production.

Only 1602 exploratory tests were completed in the first half of 1943, and 99 of these were semi-wildcats. 224 of the 1503 wildcats found oil, gas, or distillate, compared with 281 out of 1519 in the first half of 1942.

During June 1943 53 new oil, distillate, or gas-fields, new pays or extensions were opened. There were 26 new oil-fields, and 11 new pays. A major discovery may have been made in California, where there may be a ¼-ml. extension to the Republic pool, which has already given 11,000,000 brl. The drilling is to about 3100 ft.

On a seismograph-outlined anticline in Winkler County, West Texas, a discovery well has flowed 1370 brl./day from the Ellenburger at 10,647–10,697 ft. The Keystone field of the same County, another probable major discovery, has had a discovery well which flowed at 6788 brl./day from the Ellenburger at 9655 ft. There may also be production in the Clear Fork (Permian) and Silurian. There was 307 ft. of highly productive gas-distillate section in the upper Ellenburger, followed by 131 ft. of oil-zone.

Illinois had two new oil-fields and three new pays in June, while Kansas had six new fields; Oklahoma has two new oil-fields, two new gas areas, and a new pay discovery.

Tables give by States details of the June, and January–June completions for 1943, and comparative totals for May 1943 and the first half of 1942. Data presented for the June 1943 discovery wells include location, depth, producing formation, structure, initial production, oil gravity, etc. G. D. H.

938.* Preliminary Explorations Give Promise Ecuador Will Grow in Oil Importance. Anon. *Oil Wkly*, 19.7.43, **110** (7), 54.—The Ecuador oil production recovered in 1942, and preliminary work indicates a growth in importance of the country's output when equipment becomes more freely available.

Geophysical work is being continued in the coastal region, and extensive preliminary work is understood to have been carried out in the interior region.

The country's output is about 2·25 million brl./year, and crude and refined products are exported. 1·5 million brl. were exported in 1942, against 840,000 brl. in 1941.

Ancon, on the Santa Elena, is the chief field, and yields oil from Eocene sands at 1200–6000 ft. The oil is in lenticular sands and trapped against faults, and an area of about 12,000 acres has been proved. North and west of Ancon are several small fields giving oil from shallow wells and pits.

Tables give oil-production and consumption data for Ecuador in recent years. G. D. H.

939.* Testing Oil-Sand at Athabasca, Canada. Anon. *Oil Wkly*, 19.7.43, **110** (7), 56.—Deca 2, a well in the Athabasca fields, has struck oil at 1655 ft., an 8-ft. oil-saturated core having been obtained in the Grandrapids sandstone. Atadone 2, a mile to the west, found a 50-ft. oil-sand at 1651 ft. Another well is to be drilled 6 ml. to the east. G. D. H.

940.* Crude Production Higher in New Brunswick County. Anon. *Oil Wkly*, 19.7.43, **110** (7), 56.—During 1942, 27,270 brl. of crude were produced in Albert County, New Brunswick, an increase of 3464 brl. over the 1941 output. G. D. H.

941. Oil-Zones of the United States : Triassic–Jurassic. Anon. *Oil Gas J.*, 22.7.43, **42** (11), 40B.—Following the Appalachian revolution there was widespread erosion of the land surface with the deposition of salt and then red beds in the Permian. This continued into the Triassic, but in the Jurassic the sea invaded from the Gulf of Mexico and the North Pacific. In the Gulf area, red beds were deposited, followed by salt, then the Smackover limestone, which is the main producing horizon of a belt of

fields running roughly along the Louisiana–Arkansas border. Red beds rest on the Smackover, followed by the marine Cotton Valley, which produces over a more restricted area.

In the Rocky Mountain area the Sundance (Jurassic) rests on Chugwater Triassic red beds, and produces in the Wind River, Green River, and Powder River basins. There is Morrison production in Western Colorado and Utah. In Montana the Ellis (Sundance equivalent) rests unconformably on the Mississippian and is productive at Kevin-Sunburst.

There is little likelihood of finding oil in the Triassic anywhere in U.S.A. Attempts to extend Jurassic production west from Arkansas into Texas have failed, probably due to lack of porosity. The porosity may have been caused in places by erosion when the sea retreated. The formation wedges out northwards. The extension of the Jurassic south and west from Arkansas is unknown.

The Ellis and Sundance were deposited in Upper Jurassic times by sea as it spread over an old land surface, with the consequent possibility of numerous stratigraphic traps. The Morrison is largely fresh-water, and is not expected to yield much oil.

Since much of U.S.A. was land in Triassic and Jurassic times, the formations below the Lower Cretaceous are potential stratigraphic traps. From Northern Canada to Montana only the Madison has proved important, although there are limestones from Pennsylvanian to Devonian age.

A map is appended showing the Triassic and Jurassic fields, outcrops, and possibilities. G. D. H.

942. June Completions Are Up 10 per cent. Anon. *Oil Gas J.*, 22.7.43, **42** (11), 61.—1309 wells were completed in June, 10% more than in May, and 13·8% more than in June 1942; 726 were oil-wells and 157 gas-wells. Gains in completions occurred in the Appalachian area, Kentucky, Michigan, Illinois, Oklahoma, and California.

A table summarizes by States and districts the operations in June 1943, giving the numbers of each type of completion, the total footage, and the numbers of wells in different depth ranges. G. D. H.

943.* Question of Adequate Producing Ability Becomes Foremost Oil Problem. W. L. Baker. *Oil Wkly*, 26.7.43, **110** (8), 12.—The main oil-industry problem has changed from shortage of transport to shortage of production during the first half of 1943. The rising rate of manufacture of war weapons suggests that the war-time use of oil has not yet reached its peak level. Developments so far in 1943 do not indicate that a record-breaking oil output could be attained and maintained for any length of time. During July the production was about 4,100,000 brl./day, 300,000 brl./day more than in January, and only 38,000 brl./day below the all-time peak of December 1941 and January 1942. 706,881,000 brl. of oil were produced during the first half of 1943, and it seems likely that the year's total may be 1,525,000,000 brl. In 1941 it was 1,404,000,000 brl.

Above-ground stocks have fallen during the past six months.

It has been indicated that the U.S. production is not necessarily capable of being maintained at more than 4,200,000–4,300,000 brl./day during 1944 and 1945 without waste, and the rising demand is already approaching 4,200,000 brl./day.

21,412 wells were drilled in 1942, a third less than in 1941; in the first half of 1943, 8695 wells have been completed.

It is generally accepted that the current discovery rate is inadequate, and most believe that more materials and a rise in crude prices are necessary. Political circles are greatly interested in these matters, and higher crude prices seem likely to materialize. Spacing regulations have been relaxed in almost all the shallow areas, and with the completion of pipe-line, aviation spirit, and synthetic-rubber plant projects, steel allocations for drilling may become more generous. G. D. H.

944.* An Optimistic Angle on Reserves. D. Hager. *Oil Wkly*, 26.7.43, **110** (8), 18.—In the Elk Basin field of Northern Wyoming and Southern Montana prolific wells have been obtained in the Palæozoic, as might have been expected from developments at Byron farther south. All Wyoming structures not yet drilled to the deeper Permian and Pennsylvanian horizons are likely to have wells deepened rapidly. There are,

however, not many structures of any size in Northern Wyoming and Southern Montana which remain untested. In Northern and Central Montana there are numerous domes and faulted structures awaiting testing, and these may produce at depths of 3000–8000 ft.

Madison and Devonian tests are being made in Northern Montana, where there are sharp folds and fault-block structures. Nearly all these structures can be determined by surface geology, but in the Dakotas geophysical investigations will be needed in some areas. The Dakota sandstone and the Lower Palæozoic beds have oil possibilities in the Dakotas. The area of Nebraska west of the Nemaha ridge and south-east of the Black Hills uplift is merely a continuation of the Kansas producing area, and here geophysical prospecting should prove fruitful.

Arizona and Utah have favourable areas, and large sectors of West Texas and New Mexico are only partly tested. Western Kansas should provide numerous new fields. Prospecting in the Forest City basin has been unsatisfactory, and the few wells drilled scarcely scratched the area. Pennsylvanian, Devonian, and Ordovician horizons there may well provide oil- and gas-fields. It is difficult to locate structures in Michigan except by subsurface work, and this State possesses much untested acreage. Western Illinois should provide numerous limestone fields in the Devonian, Silurian, and Ordovician. Indiana has not been so intensively prospected as many assume, and Kentucky's best chances of deep production are in the Coal Basin of the central and south-west parts of the State. Mississippi has not been thoroughly prospected. Deeper production and new fields may be expected in Louisiana and Arkansas.

Geophysical investigations will be needed in Alabama, Southern Georgia, and Florida before oil in commercial quantities is likely to be found. California's best prospects lie in deepening wells in present fields and drilling old folds only slightly tested.

There are not many areas which will justify extensive prospecting campaigns, but new activities are now justified in all the outlying areas passed over lightly when the prolific East Texas and West Texas fields were found. Due consideration must be given to the choice of the best method for investigating each area. G. D. H.

945.* Results of Intensive Wildcatting Not Enough To Meet Needs. Anon. *Oil Wkly*, 26.7.43, **110** (8), 21.—The wildcatting carried out in U.S. this year is almost an all-time record, but it has not fulfilled the P.A.W. programme. 3264 wildcats were drilled in 1941, and 3166 in 1942. 4500 were demanded for 1943 in an effort to find sufficient flush fields to assure the maintenance of a producing capacity adequate to war needs.

1602 exploratory tests were completed in the first half of 1943, and while numerically at about the 1942 level, the proportion of successful wildcats is considerably below the 1942 figure. Only 14·9% of the 1943 wildcats have found oil, gas, or distillate, whereas the figure was 18·4% for the first half of 1942. In 1943 there have been found 133 new oil-fields and 51 new oil horizons, against 161 new oil-fields and 86 new oil horizons in the first half of 1942. A liberal estimate of the volume of oil found in the first half of 1943 is 700,000,000 to 750,000,000 brl.—about the same as the production in the same period—but conservative estimates reduce the discoveries to about 350,000,000 brl.

Nearly a dozen fields with reserves estimated at about 20,000,000 brl. have been found in the first half of 1943. Guijarral Hills, California, is an Eocene shore-line field which may have a reserve of 25,000,000 to 50,000,000 brl. A north-west extension or a new pool adjacent to the small but prolific Republic pool has been found, and a reserve of 15,000,000 brl. is allotted to it. On the Texas Gulf Coast there is a two-mile extension to the Stowell field. East Texas has a major discovery (New Hope), and West Texas probably has four.

No discoveries of first-class importance were made in Michigan during the first half of 1943, but Illinois had a substantial addition to its reserves.

The chief features of the wildcatting in other States and areas are noted, and a table classifies the tests by States, with some 1942 figures for comparison. G. D. H.

946.* Footage Off More Than Completions as Wells Are Shallower. Anon. *Oil Wkly*, 26.7.43, **110** (8), 32.—During the first six months of 1943, 8695 wells were completed, with an average depth of 3043 ft. The corresponding figures for the first half of 1942 were 11,157 wells and 3122 ft. This reduction in average depth is due to heavy drilling

in the Atlantic coast area, where the depths involved are relatively small. The demand for heavy crudes has led to a concentration of drilling in shallow, heavy-crude fields, and so California has drilled nearly twice as many wells as in the first half of 1942, but has increased its footage by only about one-fifth. The average well depth on the Louisiana Gulf Coast was 9087 ft., on the Upper Gulf Coast of Texas 7721 ft., and on the Lower Texas Gulf Coast 5939 ft. The average in Arkansas and Mississippi exceeds 5280 ft.

Tables give the total footage, average footage, and number of completions annually since 1925, and similar details by States and districts for the first halves of 1941, 1942, and 1943. G. D. H.

947.* Well Completions Drop in 1943; Some Areas More Active. Anon. *Oil Wkly*, 26.7.43, **110** (8), 34.—Due to man-power and supply difficulties, drilling this year has been at the lowest level since 1933. This year drilling has been at the rate of about 17,500 wells/yr., some 22% below the rate for the same period of 1942. Since wildcatting was at about the same level as in 1942, the decrease in 1943 completions is in proven fields.

Relaxation of well-spacing regulations has led to a sharp increase in drilling in California, where completions have been at nearly twice the 1942 rate. There has been great activity in shallow heavy-oil fields, the average drilling depth in the first half of 1943 being 3266 ft., against 5157 ft. in 1942 and 5759 ft. in 1941. In spite of this great increase in drilling, the producing capacity has not risen.

In the East and the Middle West and Mid-Continent also there has been some relaxation of spacing regulations. Here wildcatting results have been mediocre, and relatively few fields of major importance have been opened. Illinois has had no spectacular discoveries, but has had a substantial number of discoveries of small new fields, new pay horizons, and extensions to established fields.

Indiana's completions are down by 28%, Ohio's by 23%, Pennsylvania's by 33%, and West Virginia's by 18%. In Kansas the completion rate is almost unchanged, but there were 15%, 13%, 43%, and 41% declines in the first half of 1943 in Oklahoma, Arkansas, North Louisiana, and Texas, respectively. Montana and Wyoming had increases in drilling amounting to 28% and 59%, respectively.

A table gives by States details of the completions in the first half of 1943, with some 1942 data for comparison. G. D. H.

948.* Rigging Up Rotary for Test West of Calgary. Anon. *Oil Wkly*, 26.7.43, **110** (8), 52.—40 ml. west of Calgary rotary equipment is being installed at a well now 1490 ft. deep, and it is expected to drill to the Madison at about 3000 ft. G. D. H.

949.* Dry Gas Discovered in Fort Norman Area. Anon. *Oil Wkly*, 26.7.43, **110** (8), 52.—While drilling for water in the Fort Norman area, United States Army engineers have discovered dry gas. G. D. H.

950.* Wartime Exploration in Canada Extensive. Anon. *Oil Wkly*, 26.7.43, **110** (8), 52.—A 12,000-ft. well is to be drilled off Prince Edward Island.

In the Athabasca area wells have met the oil-saturated sands at 1655 ft., and there seem to be possibilities of a new field. So far drilling in the Taber and Ram River areas of Alberta has not shown great commercial promise. There has been some drilling at Vermilion. G. D. H.

951.* Royalite Oil Is Active in Alberta Mountains. Anon. *Oil Wkly*, 26.7.43, **110** (8), 52.—Drilling by Royalite has begun 65 ml. west of Rocky Mountain House, Alberta, and 6 ml. west of Nordegg. Home Oil drilled some wells in this general region, and Ram River Oils has also drilled in several places, the latter company being reported to have found definite prospects at one point. Gas is stated to have been found 70 ml. south-west of Rocky. Thirty years ago a well 20 ml. west of Rocky encountered oil. G. D. H.

952.* Petroleum Exploration and Development in Wartime. E. de Golyer. *Petrol. Engr*, Reference Number, **14** (10), 37.—A third of the world's total oil output formerly started on its way to market over the waters of the Gulf and Caribbean, and much of it went to U.S. North Atlantic ports. Loss of tankers through various war causes has necessitated the provision of other means of transport—tank-car, barge, and pipe-line—on a far greater scale than previously. The refining industry has been revolutionized by great changes in the types and amounts of products required.

Before the U.S. entry into the war it was believed that the rate of production could readily be substantially increased, but such a belief has proved unduly optimistic. The rate of oil discovery in the past four years has failed to maintain the reserves, and at the same time has prevented the easy attainment of an increased rate of production, which is most quickly obtained by the discovery of new fields.

There has been, and still is, an excess producing capacity, but part of this is not accessible because of transportation restrictions. Moreover, war demands are likely to increase.

In the past few years wildcatting and geophysical work have been carried out on a greater scale than ever before, but the results are below hopes and needs. Since 1938 the number of fields discovered each year has decreased. During the period 1926–1938, omitting 1932 and 1933, over 1,000,000,000 brl. of crude was discovered yearly. The average for the entire period exceeded 2,000,000,000 brl./year. The decreasing annual reserve discoveries of recent years may indicate the approach of the end of the phase of search for structural traps. Stratigraphic traps may provide the much-needed increase in producing capacity.

Exploitation also has its problems, and, due to shortage of equipment, drilling in 1942 was reduced to 60% of that in 1941. G. D. H.

Drilling.

953.* Lubrication and Inspection of Drill-Pipe-Handling Equipment. G. E. Mullinix. *Oil Wkly*, 31.5.43, **109** (13), 11–12.—Because the rotation of the sheaves in the travelling block is readily apparent, the few lubricating points on this unit are usually serviced much as specified by its manufacturer, while the hook, immediately below, is less likely to receive either regular or correct lubrication at all the dozen or more bearing or working surfaces. For the hook there may be required two types of grease, each of these again being changed for the proper weight to fit summer or winter operating temperatures. Since the types of bearing surfaces in various makes of hooks change with the individual design, it is not possible to provide a general specification which will cover all uses. The recommendation of the hook manufacturer should be followed closely, if maximum service with minimum wear is to be attained. For the bearing points equipped with grease-gun fittings, the proper seasonal grade of grease should be used, the gun being relied upon to furnish the force for expelling the old and worn grease and distributing the new lubricant around the wearing surfaces. This same type of grease, applied to those areas designated as grease-brush lubricated, may fall short of attaining its full protective purpose. Generally, a grease brushed on must have more adhesive properties than a gun grease, more body to resist being scraped from the surfaces it is intended to protect, and a higher resistance to dilution, cutting, or emulsion when in contact with water. Some companies use the same lubricant specified by the manufacturers of their wire drilling line for coating surfaces such as the hook-elevator link contact, finding that although basic conditions vary greatly, the ultimate effect of the lubricant is close to that demanded by the service.

Oil for such points as demand this type of lubricant must be of the proper consistency, non-gumming under heat, with low pour point, and fresh stock. The practice sometimes resorted to of using reclaimed oil from engine crank-cases, even if the material be strained, filtered, or even centrifuged, is one which effects a minor economy so inconsiderable when compared to the probable damaging of several hundred dollars worth of irreplaceable equipment that it should not be tolerated under any conditions. Even if the lubricating qualities of such reclaimed oil seem unimpaired, its liability to flushing from the bearing by even a small amount of water makes it a distinct hazard to effective equipment operation.

Other details are given. A. H. N.

954.* Hillside Blow-Out Necessitates Ingenious Repair Method. C. R. Dale. *Petrol. Engr*, June 1943, **14** (9), 33–36.—The topography of the Ventura field is rugged, consisting mainly of steep hills separated by canyons. The surface elevations of the wells vary over several hundred feet. One morning in early February water began flowing from the side of a hill above one of Shell's lease roads that had been built through one of the canyons. The water was followed by mud, gas, and muddy, salty water with considerable sand and a trace of oil. A crater formed, and in less than 24 hours it was approximately 10 ft. in diameter. By the time the flow of fluid was shut off this crater had reached a diameter of 50 ft. The exposure at the crater definitely had the appearance of a fault-zone. The flow gradually increased until it reached a maximum of about 10,000 brl./day, and varied between this rate and 5000 brl./day until shut off. Virtually all the flow was a frothy fluid of medium brown colour. The temperature at the mouth of the crater averaged 100° F. The flow was by surges coming at about 5-minute intervals.

Tests to find the offending well by using a detector in mud and water pumped in the surrounding wells and by chemical analysis of the crater fluid proved unsuccessful. Pressure observations were made at the various wells both with the wells shut in and while pumping in mud or water. These pressure measurements gave some interesting information on Well 116, located more than 1000 ft. from the crater, which eventually proved to be the offending well. The static pressure taken 4 hours after this well was shut in showed a formation pressure of 1700 lb./sq. in. at 7515 ft.—a pressure much lower than expected. On the following day (after being shut in for 22 hours) the pressure at 7515 ft. was 1685 lb./sq. in., or nearly the same as for the day before. A third pressure survey was made after the well had been shut in 46 hours, and the pressure at 7515 ft. was found to be 1670 lb./sq. in., or 15 lb. per sq. in. lower than the pressure measured 24 hours previously. Two readings were taken below the bottom of the tubing, and failed to indicate a static fluid gradient.

To determine definitely the source of the trouble, Shell took thermal logs of the wells surrounding the crater, beginning with Well 116, in which the pressures had been found lower than expected. The thermal logs in all the wells except Well 116 showed no break in the thermal gradient. In Well 116, however, the survey showed the temperature at 1150 ft. to be 16° higher than the normal gradient, and indicated a flow of warm fluid on the outside of the water string from a depth of about 2500 ft. up to that point. Mercaptan in gas was used as a detector after that, and its odour was noticeable in the crater 24 hours after pumping the gas. The well was then repaired and flow stopped.

A. H. N.

955.* Sodium Silicate Mud Used to Drill Deep Shale and Salt-Water Zone. C. C. Pryor. *Petrol. Engr*, June 1943, **14** (9), 108.—In a well where drilling was of an extremely hazardous nature, the drill-pipe had a great tendency to stick, and where great thickness of heaving salt-water shale zone was to be encountered, it was decided to use silicate mud. Silicate of soda muds prevent hydrous disintegration and swelling of heaving shales, and they are particularly suited to supply the high mud weights necessary to balance the abnormally high formation pressures associated with salt water. The sodium silicate liquid weighs 11·8 lb./gal., whereas ordinary water-base muds start with water at 8·33 lb./gal. This extra weight permits use of very heavy muds with greatly lowered content of suspended solids. Obviously, this feature permits easier control of the viscosity, gel strength, and other properties, simplifying control of both the salt water and the shale. Flocculation of drilling fluid due to the salt water is prevented by use of the sodium silicate, and the mud protects the open hole, preventing sloughing of the shale, stuck drill-pipe, bridging, and high-pressure gas blow-outs. Details of the well programme are given, together with properties of mud for two drillings.

The total mud cost for drilling the well to total depth of 10,336 ft. was approximately $14,000, as compared with a cost of about $25,000 for drilling other wells previous to No. 33 with water-base mud, thus resulting in a saving on mud alone of about $11,000. Down time because of stuck drill-pipe, fishing jobs for tools lost in the hole, etc., was entirely eliminated; also, the hazards of drilling the high-pressure zone were minimized because of the close control of the mud possible.

It is concluded that during the two drillings, especially in the second hole, the accomplishment of carrying a directionally drilled hole would have been virtually

impossible with almost perfect hole conditions. Cuttings obtained showed perfect bit-marks. If a water-base mud had been used the Oligocene shale would have gone completely into the mud, and the wall would subsequently have swelled or heaved into the hole, requiring reaming and washing, such as has resulted in other wells. Whipstock setting or running of knuckle-joints would have been extremely hazardous had the hole not been well conditioned. Use of silicate mud resulted in each whipstock being set and retrieved and knuckle-joints run without incident.

It was possible to land a short string of 5-in. casing on bottom and cement to the test-sands drilled. Results of drilling the two holes show the necessity of using a sodium silicate mud in operations involving extended controlled drilling in the shale in the East Hackberry Dome section. A. H. N.

956.* Electrical Logging in Oil-Base Drilling Fluid. W. A. Sawdon. *Petrol. Engr*, June 1943, **14** (9), 124.—Oil is a dielectric and, offering infinitely high resistance, carries no electric current. Oil-base drilling fluids, whether consisting entirely of oil or being compounded of oil with other substances, therefore interfere with electrical logging of a hole unless some means is provided to transmit the current from the formation to the electrode. Oil-base drilling fluids have come into rather extensive use to meet certain conditions, particularly in drilling through low-pressure sands where loss of water into the productive formation is detrimental. Equipment has therefore been developed to procure a reliable electric log of a hole when it is full of oil or an oil-base fluid. Such equipment also permits obtaining an accurate log of a hole full of fluid composed partly or completely of oil from a formation passed through or entered during drilling operations.

Drilling fluids made of native clays, with or without admixtures, or composed entirely of prepared bentonite and water, provide adequate conductivity for electrical logging operations. Even distilled water could be used for drilling and an electrical log obtained with a standard type instrument, because of the readiness of water to dissolve various substances from the formation and thus become an electrolite. When using oil, however, it is a different matter. Most oil–water emulsions offer such high electrical resistance that no electrical formation logging can be done in such a medium without employing an instrument that will cut through the oil-mud film on the wall of the open hole and make a firm contact with the formations to be traversed. By means of this contact, maintained during the passage of the instrument through the formations being logged, the electrical properties of the formations are transmitted to the instrument.

The instrument is described in detail. Typical logs are given as illustrations.
A. H. N.

957.* How to Inspect Wire Rope. A. J. Morgan. *Oil Wkly*, 7.6.43, **110** (1), 16.—Methods of inspecting wire rope can be fairly well standardized, although inspection practices must necessarily vary to allow for the peculiarities of the individual installation. Evidences of deterioration in wire rope will, within fairly wide limits, be the same whether the rope is working on a draw-works hoist or a small electric hoist. Frequency of inspection, however, can vary from daily to yearly, depending on the installation.

Deterioration of wire rope will be evidenced by: (1) Broken wires; (2) worn wires; (3) pitted or corroded wires: (4) drastic reduction in rope diameter and excessive lengthening of lay; (5) marks of mechanical abuse, such as flattening and distortion. To inspect wire rope properly is to discover its worst spot. Thus, an inspection must include the entire length of the rope. If the rope is covered throughout its length with a heavy lubricant on the outside which obscures a view of the broken wires and of the abrasion-worn surfaces of the wire, provision must be made for the inspection to ascertain where the wire breaks are occurring and the degree of the abrasion abuse the rope has suffered. In the majority of instances, however, it will be possible to ascertain the section of rope showing the most deterioration simply by looking at it.

Inspection procedure is detailed under six separate headings. A table gives diagnosis of trouble by listing characteristics and courses of different types of breaks.
A. H. N.

958.* Procedure for Reclaiming Worn Slush-Pump Rods by Metallizing. E. J. Calk. *Oil Wkly*, 7.6.43, **110** (1), 24.—The rods are first annealed, and are then mounted in a lathe between centres. Due either to service or the annealing, the rods are always found to be bent, so the first operation is to straighten them. This is done by applying heat with an acetylene torch at the point of greatest deflection or bend, and bringing a set of rollers which are mounted in the tool-holder of the lathe against the heated portion, thus forcing the rod to run true, or, in other words, straightening it. A tool is then mounted in the tool-post of the lathe and the rod machined, a very coarse feed being used so as to give a very rough machined surface, almost the same as a threading effect. At each end of this machined portion the rod is under-cut or dove-tailed, so as to lock the metallizing metal on to the rod.

Metal is then sprayed on to the rod to a sufficient depth to give an oversize of approximately $\frac{1}{32}$ in. greater than the finished size. The rods are then ground and polished to bring them back to the original size. A. H. N.

959.* How to Inspect Sheaves Used With Wire Rope. A. J. Morgan. *Oil Wkly*, 14.6.43, **110** (2), 42.—Proper inspection of wire rope must necessarily include examination of the equipment on which it is being used. In the majority of instances the cause of abnormal deterioration of wire rope is to be found in the machinery on which it is operating. The principal items to be checked are: (1) Sheaves. (2) Drums. (3) Reeving. (4) General operating conditions.

Sheaves are discussed and the necessity for the inspection of their size, grooves, materials, operation, and general conditions is stressed. A sheave that is out-of-round or has a flat spot on its bearing surface will also cause whipping of the rope, and must be repaired immediately. Sheave-grooves should be either machined or ground to a smooth and true surface and contour. When a sheave-flange is broken off, the wire rope may jump this flange and cause serious damage both to the rope itself and to the machinery. If the rope does not jump the flange, it is at least likely to come in contact with the sharp edges of the broken flange, which may gouge it badly. Such sheaves should be replaced without delay. A. H. N.

960.* When to Replace Wire Rope. A. J. Morgan. *Oil Wkly*, 28.6.43, **110** (4), 36.—Important though it is, the question of when a wire rope should be replaced is very difficult to answer in general terms. There are no hard-and-fast rules that tell just when to remove rope from all installations. Safe, economical, and practical rope-removal practice can be established only by close study of each installation. Two considerations apply in every case: (1) safety; (2) economy. Thus, the question to be answered really is, "How early should a rope be removed for safety's sake; and how late can it be removed for economy?"

It is common practice to allow a factor of safety in wire-rope installations. This factor of safety is the ratio between the maximum calculated load and the ultimate strength of the rope. These factors of safety vary considerably according to the installation. They are large where rope failure might cause loss of life or serious property damage. Such safety factors, however, do not afford a really accurate measure of the safety of an installation. The true gauge of safety is not the original factor of safety when the rope was new, but rather the amount of usable life left when it is removed. Economy demands that, in so far as possible, the maximum life of a wire rope be obtained. Good rope practice attempts to establish the greatest length of service commensurate with safety.

Where corrosion is a factor there is no safe guide for judging the proper time of removal of the rope. Even ultimate strength tests on corroded ropes can be misleading, because they cannot indicate the rapid rate of deterioration that might occur were the rope continued in service. Corrosion in a wire rope can be controlled by proper and suitable lubrication. When corrosion has started in a rope it can be retarded by lubrication, but the lubricant cannot restore the rope to its original condition; therefore, this rope must be regarded as a corroded rope. A. H. N.

961. Patents on Drilling. J. D. Isaacks and R. Jones. U.S.P. 2,319,236, 18.5.43. Appl. 22.8.40. Deflecting tool with bit assembly.

H. S. T. Eyck and C. A. Fulton. U.S.P. 2,319,395, 18.5.43. Appl. 17.6.51. Aqueous drilling mud containing mineral phosphate.

C. S. Penfield. U.S.P. 2,319,514, 18.5.43. Appl. 8.9.41. Apparatus for controlling fluid flow through drill-strings.

E. E. Post and C. F. Bonnet. U.S.P. 2,319,705, 18.5.43. Appl. 27.8.41. Drilling mud having clay and pectate pulp.

J. D. Chesnut. U.S.P. 2,319,720, 18.5.43. Appl. 30.6.40. Process for cementing oil-wells and the like.

S. Speckert. U.S.P. 2,320,107, 25.5.43. Appl. 14.7.41. Alligning connection for drill-collars.

A. W. Kammerer. U.S.P. 2,320,136, 25.5.43. Appl. 30.9.40. Well drill-bit for rotary systems.

A. W. Kammerer. U.S.P. 2,320,137, 25.8.43. Appl. 12.8.41. Rotary drill-bit.

R. A. Doughty. U.S.P. 2,320,543, 1.6.43. Appl. 31.10.41. Wire-rope clamp and socket.

C. L. Allen. U.S.P. 2,320,550, 1.6.43. Appl. 24.6.40. Well drilling-bit which is self-feeding.

B. H. Barnes and B. S. Minor. U.S.P. 2,320,553, 1.6.43. Appl. 25.6.39. Means for proportioning expansible collars on pipe or the like.

B. S. Lindsey. U.S.P. 2,320,622, 1.6.43. Appl. 13.5.40. Conditioning of drilling muds.

J. Neufeld. U.S.P. 2,320,643, 1.6.43. Appl. 4.5.41. Well-surveying method and apparatus.

D. Scaramucci. U.S.P. 2,320,670, 1.6.43. Appl. 12.7.39. Well-casing attachment with a ball-valve.

W. G. Green. U.S.P. 2,320,863, 1.6.43. Appl. 21.6.40. Well-surveying method and apparatus.

W. L. Russell. U.S.P. 2,320,890, 1.6.43. Appl. 2.8.41. Method of geophysical prospecting in wells.

S. A. Scherbatskoy and R. E. Fearon. U.S.P. 2,320,892, 1.6.43. Appl. 31.1.42. Method of geophysical prospecting in wells.

S. W. Webster. U.S.P. 2,320,901, 1.6.43. Appl. 8.6.40. Water-cooled cathead.

J. W. MacClatchie. U.S.P. 2,320,974, 1.6.43. Appl. 18.8.41. Blow-out preventer.

J. W. MacClatchie. U.S.P. 2,320,975, 1.6.43. Appl. 30.12.41. Piston for high-pressure operations, fitted with packings.

J. M. Range. U.S.P. 2,321,243, 8.6.43. Appl. 19.2.40. Shab-shaker.

J. E. Reed. U.S.P. 2,321,245, 8.6.43. Appl. 14.4.41. Rat-hole swivel wrench for a unitary, well-rig, string-joint making and breaking apparatus.

L. G. Howell. U.S.P. 2,321,295, 8.6.43. Appl. 23.6.41. Apparatus for logging bore-holes using Geiger–Muller counter.

G. F. Fermier. U.S.P. 2,321,474, 8.6.43. Appl. 8.1.40. Core-orientating device.

G. G. Harrington, T. H. Stancliff, and C. H. Black. U.S.P. 2,321,484, 8.6.43. Appl. 4.3.40. Drill-bit for rotary system.

B. W. Sewell. U.S.P. 2,322,064, 15.6.43. Appl. 22.12.41. Coring device having pressure-retaining elements.

T. B. Lewis. U.S.P. 2,322,150, 15.6.43. Appl. 18.5.40. Derrick and method of its erection.

H. Allen. U.S.P. 2,322,269, 22.6.43. Appl. 14.10.40. Blow-out preventer of the ram type.

R. M. Dempsey. U.S.P. 2,322,425, 22.6.43. Appl. 12.8.40. Dumping bailer with a collar and a number of spring arms on the sides.

R. W. Stuart. U.S.P. 2,322,484, 22.6.43. Appl. 20.9.40. Method for removing mud-sheaths for completion of wells by using a solution of a phosphate.

L. G. Howell and L. W. Blau. U.S.P. 2,322,634, 22.6.43. Appl. 23.6.41. Method and apparatus for logging bore-holes.

A. B. Williamson. U.S.P. 2,322,679, 22.6.43. Appl. 4.2.41. Rotating blow-out preventer.

R. B. Kinzbach. U.S.P. 2,322,694, 22.6.43. Appl. 11.10.41. Pipe-cutter and reamer with a knife moving radially outward.

R. B. Kinzbach. U.S.P. 2,322,695, 22.6.43. Appl. 11.5.42. Pipe-milling device to be used in milling pipes in wells.

W. Gerstenkorn. U.S.P. 2,323,027, 29.6.43. Appl. 25.9.41. Drilling implement used with rotary drilling bits and comprising a one-way clutch.

A. R. Maier. U.S.P. 2,323,095, 29.6.43. Appl. 13.5.41. Catline apparatus for hoists on well-drilling units. A. H. N.

Production.

962. Viscosity of Natural Gases. L. B. Bicher and D. L. Katz. *Petrol Tech.*, July 1943, **6** (4), A.I.M.M.E. Tech. Pub. No. 1599, 1–7.—The viscosity of natural gas is required for computing the pressure drop in pipes or porous media.

The viscosities of methane, propane, and four of their binary mixtures have been determined at pressures from 400 to 5000 lb./in.^{2} and temperatures of 77–437° F., with an experimental accuracy of 3·2%. The viscosity data have been plotted as a function of molecular weight with lines of constant pressure, and extrapolated to pressures above 5000 lb./in.^{2} and temperatures below 77° F. A further graph shows the viscosity of normal paraffins at atmospheric pressure as a function of molecular weight.

Comparison of the viscosities of light hydrocarbon mixtures under pressure (up to 2500 lb./in.^{2}) as predicted from the molecular weight with observed values shows an average deviation of 5·8%. Prediction should not be made near the critical region or in the two-phase region, for in the former case the properties vary rapidly, in the latter they are a function of the concentration of the constituents as well as of the molecular weight.

Under atmospheric pressure the molal average viscosity of nitrogen and the nitrogen-free hydrocarbon gas reproduces the experimental value satisfactorily, and under high pressure a similar procedure should be the best approximation now available.

A series of graphs gives the relationship between viscosity and molecular weight for methane–propane mixtures at pressures up to 10,000 lb./in.^{2} and temperatures of 0°, 60°, 100°, 200°, 300°, and 400° F.

Another graph relates viscosity at atmospheric pressure and the molecular weight of paraffins for various temperatures from −40° C. to 480° C. G. D. H.

963. Selective Acidizing and Permeability Determination by an Electrical Method. D. G. Hefley and P. E. Fitzgerald. *Petrol Tech.*, July 1943, **6** (4); A.I.M.M.E. Tech. Pub. No. 1604, 1–9.—An apparatus has been developed which permits selective acidization of producing formations and determination of the relative permeability of a formation by fluid injection. This apparatus, known as the "Electric Pilot," is an electrical fluid-interface locator, the electrical circuit of which is completed when the

electrodes in the well are in contact with a conductive fluid, but is not completed when immersed in a non-conductive fluid.

In acidizing the lower pay of a multiple zone well the electrode-seating nipple is installed on the lower end of the tubing, and sufficient tubing is run into the well to place the nipple 2 ft. above the top level to which acid should rise during the treatment. The electrode unit is run down to the nipple seating, and when in this position the electrodes project down below the bottom of the tubing. Acid is pumped down the tubing and discharged into the well below the electrodes, while oil is simultaneously pumped into the annulus between the casing and the tubing. Separate injection of oil and acid reduces turbulence at the interface and emulsion formation. Readings, taken at the surface, of the current passing between the submerged electrodes indicate whether the oil–acid interface is too high or too low, and the pumping rates are adjusted accordingly, so as to maintain the interface at the desired level.

In the permeability survey sufficient salt water is introduced into the bottom of the well in order to cover all the section to be surveyed, and this water is forced into the formation by introducing oil into the well. The rate of fall of the salt water–oil interface is determined by means of the interface locator. From these data the relative permeability of various sections of the formation can be calculated.

The results are given for a number of typical acidizing applications in which the interface locator was used to control the acid. G. D. H.

964. Engineering Features of the Shuler Field and Unit Operation. H. H. Kaveler. *Petrol. Tech.*, July 1943, **6** (4); A.I.M.M.E. Tech. Pub. No. 1605, 1–28.—The Cotton Valley formation and the Reynolds oolite are oil productive formations in the Shuler field, but the Jones sand pool, at a depth of 7500 ft., developed with 146 wells on 20-acre spacing, is the reservoir of principal interest.

The Jones sand sandstone reservoir is an anticlinal trap, typically gas-drive or depletion type in performance. The core analyses from 88% of the wells drilled, together with drilling time and electric-log data, yield an accurate estimate of the "productive" sand thickness and its areal distribution over the pool. Accurate production statistics, monthly reservoir-pressure surveys, and bottom-hole sample analyses when correlated by the "material-balance equation" show unusually good agreement with that principle. Estimates of oil initially in place made by the material-balance method and the sand-volume method are in good agreement at 116,000,000–120,000,000 brl. The reservoir-pressure history of the pool reflects the reaction of a reservoir to production, proration, and secondary-recovery practices.

The cost of the extensive programme of reservoir study in the Jones sand pool has been estimated, in order to emphasize the value derived from such an investment through better understanding of a reservoir's reaction to production practices.

Unit operation of 140 of the 146 Jones sand wells made possible an effective unitized gas-injection pressure-maintenance programme. Reservoir-pressure decline was arrested, natural flow was maintained, and pumping and lease equipment were conserved. An increased ultimate recovery of 20,000,000 brl. beyond the estimated 34,000,000 brl. primary recovery is indicated at present.

Extension of the Jones sand unit to include the undeveloped Cotton Valley formation will permit additional recovery of otherwise uneconomic reserves of oil through wells no longer required in the Jones sand operations. G. D. H.

965. Role of Connate Water in Secondary Recovery of Oil. P. A. Dickey and R. B. Bossler. *Petrol. Tech.*, July 1943, **6** (4); A.I.M.M.E. Tech. Pub. No. 1608, 1–9.—The presence of connate water in oil-sands is of far greater practical significance in secondary recovery operations than in primary production. The percentage saturations of oil, water, and gas in a depleted field determine whether it will be possible economically to recover oil by secondary methods, and whether water-flooding or gas-drive will be successful. It appears likely that economic recovery of oil by secondary water-flooding can occur only when a rich bank of oil is formed by the encroaching water. If the sand has a greater effective permeability to water than to oil before flooding, a bank will not be formed, and water-flooding will not be successful, although gas-drive may be. Published laboratory data indicate that the effective permeability of a sand to oil and water depends primarily on the degree of saturation of the sand by each of

these phases, and that a small difference in relative saturation produces a large difference in effective permeability to the phase in question. Thus, there exists a critical range of saturations wherein a small change in oil or water content of a sand will make water-flooding possible or impossible. In gas-drive operations the degree of water saturation is important but less critical. The presence of connate water in a sand increases the proportion of the residual oil that may be recovered by gas-drive. Sands with oil-saturations too low and water-saturations too high to make water-flooding possible can often be subjected to gas-drive with economic recovery of oil.

The results of laboratory work on test samples which do not contain water cannot be applied to normal field operations. More tests on cores containing water as well as oil are desirable, and the improvement of coring technique is necessary, but sufficient data are already available to enable an operator to use core data intelligently in assessing the possibilities of a secondary recovery programme. G. D. H.

966. Completion Records Aid Conservation of Strategic Materials in Wells. V. E. Baum. *Oil Gas J.*, 1.7.43, **42** (8), 46.—The use of correct and accurate records is advocated and explained, together with advantages accruing therefrom. A. H. N.

967.* Gas-Lift Unit Driven by Wire Extension from Another Well. C. A. McGill. *Oil Wkly*, 5.7.43, **110** (5), 16.—The short paper described how a gas-lift well was regulated from another. Deciding that it was feasible to drive the surface jack from the unit on an adjoining well, the horseheads on both jacks were extended by welding channel iron to the lower portions, thus bringing a guide for the wire line only a few inches above the foundation frame of the units. The wire line operating the subsurface valve on the driving unit was extended around the horsehead pulley, brought back down the head-guide, and thence across the intervening territory on wooden hold-ups to the reins of the driven surface unit. Two small holes were drilled into the lower portion of the driven head to permit the wire from the driving unit to be "reined in."

Operation requires that the driven unit be stripped of some of its counterweight, and the driving unit requires additional weight to the beam. Both units produce in a similar manner, and have given efficient service. A. H. N.

968. Combination Gas-Lift and Repressuring Plant Used in Payton, Texas, Pool. H. F. Simons. *Oil Gas J.*, 1.7.43, **42** (8), 32–34.—The principal requirement for both repressuring and gas-lifting of the production is a source of high-pressure gas. When it became necessary to install lifting equipment in the field, gas-lift was considered as a method. Shortly after the field's discovery and development in 1938, efforts were made to unitize and repressure the entire pool, but complete agreement among the operators could not be reached, and the plan was dropped. However, the operators of two of the leases decided to repressure these properties and to build a plant which could be used for both repressuring and gas-lift. The plant was built in 1939, and has operated continuously since. At the present time it is supplying 1,250,000 cu. ft. of gas for injection into the formation through three wells and for the lifting of the production from sixteen wells by gas-lift. There are two flowing wells on the properties and one pumping well; only recently, a third well which had been flowing was converted to a gas-lift well.

The leases being repressured are in one corner of the field, and consequently it is possible to maintain the pressure in the formation under a portion of the property without driving the oil to other parts of the structure. The producing formation is the Yates sand, which is rather clean in some sections of the lease, and contains considerable cementing material in others. The sand averages approximately 60 ft. of gas and oil sand which in the best wells is a fairly solid sand body, but which in poorer wells is quite streaked with lime and shale.

As far as the gas-lift portion of the operation is concerned, it is a closed system, the gas used to produce the oil being returned to the plant for compression and use again. The only time any gas is lost is when several wells happen to produce simultaneously and the separator capacity is not sufficient to handle the gas. A small amount is then vented instead of being delivered to the compressors. This does not happen very often, and the curing of this small operating deficiency would require a greater investment than the saving obtained would warrant. Details of the operation are given. A. H. N.

969. Oil-Well Pumping Practices. Part 1. J. Zaba. *Oil Gas J.*, 1.7.43, **42** (8), 29–31.—Nearly 90% of all the wells operating in the U.S.A. on January 1, 1943, produced oil to tanks by application of different methods of mechanical lift. Among the methods used, oil-well pumping is applied in such an overwhelming majority of cases that it has to be considered as the most important of all the oil-field production practices. It is the purpose of this series of articles to present a concise treatise on the subject of modern pumping operations, taking into consideration their present status, along these three lines of evolution. To accomplish this, the articles will discuss modern pumping equipment, both surface and subsurface, and will present the practical application of the results of research to oil-well pumping problems. No attempt will be made to include theoretical investigations which are still controversial, or which, because of their nature, belong in the realm of pure research. The practical side of the subject will be emphasized, even though this may necessitate discussion of subjects which may appear quite fundamental.

This first part deals with the elements of reservoir behaviour, discussing the types of drive and definitions of common terms, and thus forms an introductory portion of the series. A. H. N.

970.* Simplification Makes Dehydration System More Efficient, Economical. F. Briggs. *Oil Wkly*, 28.6.43, **110** (4), 33.—After eliminating the use of two steam-boilers, four medium-size steam-driven pumps, and four 1000-brl. tanks from a dehydrating system, the characteristics of the processed crude were improved to the extent of increasing the gravity by one degree, the basic sediment and water content was lowered by ¾ of 1%, and the saving in electrical energy exceeded 10%. The salvage value of the items removed from the system constituted an important windfall, to which was added the invaluable time of one man formerly required. The plant is described. A. H. N.

971.* Secondary Recovery in Terms of the Engineering Problem. G. H. Fancher. *Oil Wkly*, 28.6.43. **110** (4), 24.—Prof. Fancher discusses at some length the formulæ and principles involved in problems of flow of fluids through formations followed by economic considerations. It is the author's firm belief that secondary-recovery operations must be considered seriously by operators and technologists in order to increase the recovery of oil in the U.S.A., prolong the life of producing properties, and prevent an irretrievable loss to the nation of its most valuable single natural resource. Too frequently secondary methods of recovery are regarded as methods of last resort and are looked upon as something only for the stripper operator. This attitude may be due to the far too prevalent custom in cost accounting, particularly in the case of the larger operator, of assessing a stripper property with a share of all costs of a district, including the overhead for complex executive and exploration staffs, where such services are no longer useful to the stripper property. It is felt that comparison only of actual expense on a secondary-recovery project to income should be made. If this were done, a certain profit/barrel of oil recovered might be found. No quarrel with accounting methods for various purposes is intended. The important fact, after all, in secondary recovery, is the recovery of a barrel of oil which otherwise would be lost to man's use for ever. Perhaps sometime it will not be necessary to use the adjective "secondary," but it will be realized that oil recovery implies not only wise utilization of nature's energy in an oil-field, but also the augmentation of her energy whenever necessary. The time to water-flood or inject gas is at the time the field is discovered, if maximum recovery at a desirable rate cannot be achieved otherwise.

The development of secondary-recovery projects is more dependent on the obtainment of an increase in the price of crude oil than any other factor. The operators and geologists know where the oil is, the petroleum engineers know how to get it out of the ground, in large measure the wells and equipment are available, and the nation needs the oil. All that is lacking is profit incentive. A price increase is fully justified and necessary to insure the maximum recovery from oil-sands of every barrel of oil which can be obtained. The war situation introduces further considerations for such conclusions. A. H. N.

972.* The Temperature Bomb. F. Briggs. *Oil Wkly*, 28.6.43, **110** (4), 15–17.—Two types of well thermometers are employed: those that use the principle of the temperature-caused variation in resistance of a conductor of electricity, and those that

depend on the temperature-caused expansion of a fluid. In the resistance-type thermometer, the electrical conductor is calibrated so that for a certain resistance to the current flowing, a corresponding temperature of the medium surrounding the thermometer is indicated. The fluid-expansion type, commonly referred to as "temperature bomb," likewise is calibrated to denote a certain temperature for a corresponding expansion of the fluid.

Similar to the pressure-determining devices used in subsurface work, the temperature bomb is limited in cross-sectional area so that it may work in conventional size pipe. The principle of operation is also the same for these two types of instruments—namely, the transmittal of a pressure change through some recording mechanism. The temperature bomb contains a gas-filled bulb, connected to a Bourdon tube, to which is attached a recording pen. The pen traces on a chart placed in a clock-driven drum. As the temperature of the medium around the bulb changes, the gas in the bulb and tube expands or contracts, causing the recording pen to move. This movement is then traced on the chart as a curve of displacement against time. The sealed bulb acting as the expansion chamber may contain methyl chloride. This gas, CH_3Cl, is very responsive to temperature changes, and expands very nearly in proportion to temperature increases. If the expansion of methyl chloride when plotted against temperature is a straight line, this means that the stylus movement will be the same for certain temperature changes over the range of the instrument.

Dimensional and other details of the Amerada temperature bomb are given, together with method of its operation. Interpretation of temperature charts—*e.g.*, in cementing operations or in determining points of fluid entrance into the well—are given with magnified illustrations. A. H. N.

973.* Synchronized Gas-Lift System Levels Compressor-Plant Load. T. H. Rodgers. *Oil Wkly*, 14.6.43, **110** (2), 26.—By pairing wells so that input gas goes to only two units at any one instant, and grouping these pairs so as to keep gas demand as even as possible from pair to pair, it is possible to plan the layout of a gas-lift installation which will have uniform gas demand, and from which will result a uniform main-line pressure. Distribution of gas to the individual well is then determined through an intermitter-time scale which will produce best results, well data being correlated with that of other wells so as to adhere as closely as possible to the predetermined optimum condition in which but two wells are on input simultaneously. The use of synchronous motor-drives for the intermitters permits maintenance of such a closely regulated time-flow cycle, once it is established.

The gas-lift system employed in one field is discussed. On an individual well basis, experience in this field shows that the best results are obtained from gas-lift when three physical conditions are met: first, the static pressure should be high and exhibit a fairly flat decline curve; second, the formation gas–oil ratio should be around 1000 cu. ft./brl. or more; and third, water cuts should not exceed 20%. Some water shut-off programmes depend on good cement contact with thin shale bodies to protect producing sands below. When producing a well in such circumstances it is often thought desirable to hold a back pressure against the formation to prevent excessive sand movement into the liner such as occurs with large pressure differentials across the sand face and high fluid velocities, and so prevent the thin shale from caving. This is easily done in gas-lift work by placing a choke in the surface tree to hold any amount of tubing pressure.

A detailed description of the field's layout, and systems used, is given in this long paper. A. H. N.

974.* The Dynamometer. F. Briggs. *Oil Wkly*, 14.6.43, **110** (2), 34.—There are three principal types of polished-rod dynamometers: those of a strictly mechanical nature that indicate the load by measuring stretch (over a short length) of the polished rod; the hydraulic type that compresses a liquid proportionate to the applied load; and the electrical strain-gauge type that, by suitable intricate devices, measures a self-generated current that flows in amounts proportionate to the load on the polished rod. Each type is described. "Harmonics" are explained in simple brief sentences. A diagram gives the shape of dynamometer cards where harmonics of second, third, fourth, and sixth orders obtain.

In a well with a fluid pound the load curve shows sudden reductions on the down-stroke. This is what should be expected; the pump plunger, striking the fluid level in the partly filled working barrel, momentarily receives an upward push, thus relieving some of the load for an instant. Such a condition changes the usual shape of the trouble-free load curve; additional vibrations are introduced which are responsible. Sucker rods operating in this type of well are subject to severe damage if the loads are great, and usually give poor service. Slowing the well down, shortening the length of stroke, introducing a smaller pump, are remedies that relieve a pound due to a pump-off condition. A pound due to a gas condition is another problem, and only experimentation with various speeds and strokes, as well as subsurface equipment, will determine the best operation.

Excessive loads due to the friction between rods and cork-screwed tubing, or between a tight-fitting plunger and the working barrel, are indicated by a continual increase in the load curve for the complete up-stroke; the general shape of the curve slopes up in the direction of the up-stroke. Only facts or experiments will determine which of the frictional conditions is responsible; the pump should be pulled and examined for wear. If pump changes have no effect the tubing can be raised 1 or 2 feet and a further trial made. If the hole is crooked, there is little to be done other than to try rod-guides.

Detection of other causes of trouble—*e.g.*, leaks around plunger cups, effectiveness of counterbalance, etc.—are discussed. A. H. N.

975.* Industry Must Adopt Co-operative Gas-Injection Programmes. H. W. Harts. *Oil Wkly*, 14.6.43, **110** (2), 18.—The problem is briefly discussed from the engineering, conservation, and legal viewpoints. Pooling systems are similarly described and recommended. It is pointed out that many men interested in the production of oil, and even some petroleum engineers, undoubtedly think that some of this procedure may show socialistic tendencies; but the recent trend of oil production and the conservation of gas leads in this direction, and the first indication of an actual shortage of petroleum in the U.S.A. will undoubtedly precipitate legislation somewhat on these lines, and this, in turn, will have more than a minor bearing on the future producing practices in the U.S.A. If a sufficient number of operators in new producing areas take steps to conserve their resources and prevent waste and loss of production, they will undoubtedly be permitted to produce their properties as they have in the past; however, if the wasteful practices are continued, in all probability either State or federal agencies will step into the picture and tell the companies or individuals interested in oil production how and when they will be permitted to operate their various producing properties. A. H. N.

976.* Wasson Operators Propose New Production Schedule. Anon. *Oil Wkly*, 7.6.43, **110** (1), 22.—Bottom-hole energy, man-power, and automotive equipment could be conserved and load-capacities imposed on pipe-lines and gasoline plants could be smoothed out, if wells in the Wasson field, Gains and Yoakum Counties, West Texas, were permitted to produce several days' allowable at one flow-period instead of producing their allotment each day. This is the opinion of a majority of operators in the field after conducting flow tests. Flow tests were made on sixteen representative wells in the field. The results of these gas–oil ratio flow tests taken on ten wells by one operator indicate that the lowest ratio is obtained when the well is permitted to produce a quantity of oil at least comparable to 5 days' allowable in one flow-period. The average gas–oil ratio decreases with the quantity of fluid produced at one flow, a ratio of 643 being obtained when the quantity of oil produced was equivalent to 1 day's allowable, 601 for 2 days' allowable, 557 for 3 days' allowable, and 551 for 4 days' allowable.

Test results of another operator working independently substantiate those previously outlined—namely, that the majority of wells in the Wasson field could produce in excess of five times the present daily allowable with an accompanying reduction in gas–oil ratios. Briefly, the proposal is that any operator may elect to depart from the present regulations for the field, or he may continue to abide by them. If an operator decides to adopt the new production schedule, he must follow these terms: (1) Send written notice to the Texas Railroad Commission and submit a producing schedule for

a month's period; (2) this revised schedule must provide for each well being produced at least six times in any 30- or 31-day month; (3) the amount produced from any well in any one day shall not exceed 110% of the allowable as calculated by dividing the monthly allowable, as determined from the commission proration schedule, by the number of times a well is scheduled to produce that month. A. H. N.

977.* **Calculating Production Decline Curves for Natural Gas Wells. Part 2.** A. R. Greer. *Petrol. Engr*, June 1943, **14** (9), 90.—A short discussion involves the mathematics of calculating the production curves, and must be read in full to be understood and appreciated. The paper deals particularly with calculations where deviations from the simple gas laws are large and known for different conditions. A. H. N.

978.* **A New Conception of Acidizing. Part 2.** C. E. Clason. *Petrol. Engr*, June 1943, **14** (9), 76.—An example of the increase in flowing capacity by enlargement of crevices is worked out. It is realized that the limestone has a certain permeability and effective porosity apart from those of the crevices considered. Enlargement of the crevices therefore enlarges the channels or conduits of the system as a whole towards the well-bore. The net result can be an increase in production of 200 or 300 times that of the original. More efficiency will result from enlarging the drainage area, because oil and gas will be drawn from a greater distance around the well-bore by virtue of less potential energy being required to move the oil and gas through the formation to the bore of the well. Such a well could be treated with a greater volume of acid than another well the pay formation of which is the same thickness but of uniform permeability and porosity, before the economic limit was reached. That limit is reached when a further treatment would produce only a slight increase in radius of penetration compared with the enlargement of the crevices, and result in no greater volume of production. In areas where formations respond favourably to acid treatment such as just discussed, wells could be spaced farther apart than usual after it was proved that production could be increased by this method.

Different fields require different methods of acidizing, so the author gives descriptions of typical methods which may be used, with appropriate modifications, as standards. Acidizing gas-wells is first discussed. The practices discussed, with the exception of water-washes, are also applicable to oil-wells. Certain procedures are common to specific gas-fields or areas. These procedures have been worked out, and are based upon calculations and reasoning, plus experience. The main procedure in the Hugoton and Panhandle areas is to give one or more small mud-clean-out shots with a weak acid solution preliminary to initial treatments with larger volumes of acid. Water is injected between stages to aid in washing-out insolubles and for diluting spent acid so as to accomplish its quicker and better removal.

A compressor and measuring line float, or Echometer, is used to displace and measure the acid injection when using gas as a pressuring medium. A water load with the well tubed and the gas-lift principle of unloading is also used. Both penetrating acid and gypsum retention are applicable to this work, as well as water for washing purposes, treated with one-half the amount used to make penetrating acid. In other areas, such as the chalk-gas production fields near Monroe, Louisiana, gas pressuring alone is used, as water seems to have a plugging effect on the formation. Other types of formation producing gas in Louisiana and elsewhere can undoubtedly benefit from the washing process, especially if the rock pressure is less than 500 lb. but great enough to unload the well. Details of gas-well washing and acidizing are then given. The following schedule is given in full, as it appears of interest: check open flow of well; then place 500 gal. or the proper amount of 5% acid in the open hole and blow out into the air for 3–4 hours; this flocculates and removes mud. In some cases two treatments may be made. Check again for open flow and then displace 1000 gal. of 15% acid from the well-bore. The well can be blown until the gas is fairly dry. Check increase in open flow. In the next stage treat with 4000 gal. of 15% acid, followed by 4000 gal. of water used in the same manner as a wash, separately, allowing a longer time for blowing out. Check again, and if a 50–100% increase is obtained over that which the well showed after the last weak acid wash, it appears favourable for a larger and additional treatment. A volume of 8000 gal. would penetrate the formation 40% farther than 4000 gal., and approximately 8000 gal. of water should be used in washing. Again check

open flow. If the flow is 25–100% or more than the preceding treatment, it would certainly indicate that crevice conditions exist, and a still larger stage treatment could then be applied. A treatment of 12,000 gal. would penetrate at least 40% farther than the previous 8000 gal. for the same conditions in the pay, and should be washed with 12,000 gal. water. It is problematical where such a procedure would end, as this would make a total of 25,000 gal., yet it is conceivable that a total treatment of 50,000 gal. would be feasible in some wells if the method is used as described. A. H. N.

979.* Inspection and Analysis of Formation Samples. L. C. Uren. *Petrol. Engr*, June 1943, **14** (9), 51.—Porosity is defined and explained. Measurement of bulk volume of a rock specimen may be done: (1) By immersion in a liquid, such as mercury, which does not enter the pore-spaces of the specimen, and measuring the increase in volume of the liquid; (2) by saturating the pore-space with a liquid, such as acetylene tetrachloride, then immersing the specimen in a measured volume of a fluid and noting the increase in apparent volume of the fluid; (3) by coating the specimen with a water-impervious substance that does not enter the pore-spaces of the specimen, then weighing the coated specimen, first in air and then in water, and computing the volume from the known density of the water and the loss of weight when immersed in water; (4) if the specimen is dressed to some regular geometrical form, such as a cube, its bulk volume can be computed directly from its measured dimensions; and (5) if the volume of the pores and specific gravity of the mineral substance of which the specimen is composed are known, the bulk volume can be computed from the dry weight of the specimen. Each method is then detailed.

The volume of pore-space within a rock specimen can be determined indirectly by measuring the bulk volume and mineral substance volume. Subtracting the volume of the mineral substance from the bulk volume gives the volume of the pores. The volume of the mineral substance can be determined in several ways: (1) By gas displacement; (2) by comparison of the dry weight of the specimen with the weight when saturated with a liquid of known density, and (4) by crushing the sample to separate the individual grains and then determining their volume by weighing them in a pyknometer of known volume. These several methods are described separately.

The long paper ends with an examination of the methods of studying grain size and distribution. A. H. N.

980.* Gas Repressuring at Glenn Pool. K. B. Barnes and J. F. Sage. *Oil Wkly*, 31.5.43, **109** (13), 19. *Paper Presented before American Petroleum Institute.*—Glenn Pool was the first major oil-pool in Oklahoma. Original development took place mainly during 1906–1909. Peak production has been reported as 117,400 brl. daily in June 1907. The southern portion of the pool, covering 8100 acres, is the most prolific sector. The North Extension area covers 8400 acres. Oil-production and well-completion records for early years are very incomplete. However, it is believed the southern sector has recovered at least 25,000 brl./acre to date, while recovery from North Extension has been about 4000, with total for entire reservoir in order of 222,000,000 to 236,000,000 brl. The reservoir is of gas-expansion type, and the southern sector contains an unusually thick section of oil-sand.

Systematic gas repressuring or "gas-drive" operations were started in May 1940, and very successful results obtained. By 1st April, 1943, the repressure effort had been expanded to cover work done by 7 companies on 18 leases, with a total of 2000 acres partly under repressure operation. A total of 308 old oil-wells are being affected, while 51 new oil-wells and 65 new input wells have been drilled. The production of these projects was 714 brl. daily before repressuring. During March 1943 the average production was 1983 brl./day, or an increase of 1269 brl. An average of 1·42 tons of steel, the majority consisting of second-hand light-weight casing, was used/brl./day of increased oil rate.

An accurate method of estimating the increased oil recovery that may be obtained at Glenn Pool by repressuring has not yet been developed. In some work reliance has been made on comparisons with similar projects elsewhere, accounting for differences in past oil production, sand character, thickness, per cent. oil and water saturation, and other pertinent factors. The most similar operations in the Mid-Continent are probably the pattern-type air-gas drives in the northern portion of the Nowata,

Oklahoma, field, and some comparisons with these have indicated that repressure yields, for the better Glenn Pool properties, may be between 5000 and 10,000 brl./acre. Other investigators have examined recovery data for a large number of gas-repressuring projects in the Mid-Continent which have had substantial operating history, and found that on the average the successful operations will obtain about 25% more oil than would have been recovered ultimately without repressuring. On this basis, with the average recovery expectancy at Glenn Pool without repressuring on the order of 28,000 brl./acre, the repressuring might effect an additional yield of about 7000 brl./acre.

Neither of the foregoing methods of recovery estimation is precise in character. They depend specifically on the exact sand conditions and the existing oil and water saturation values under a particular lease, which are factors judged by broad experience. Possibly the best method that might be used should be based on the average percentage of oil and water saturation existing under a given lease. The recovery expectancy of the repressuring should be the difference between the existing per cent. oil and water saturation at the start of the work and a lower per cent. oil and water saturation that would be obtained when the produced gas–oil ratio reached a limiting economic point. Such a method, however, required reliable relative permeability–saturation curves for the sand and oil and water saturation core data which are representative of conditions in place in the formation. A. H. N.

981.* Utilizing Well Energy in Cleaning Flow-Lines of Paraffin. F. Briggs. *Oil Wkly*, 31.5.43, **109** (13), 13–14.—To clean flow-lines without using steam power, one company uses cleaning tool pushed by gas pressure from the well. The first go-devil was fashioned in the shape of a bullet, from a short piece of hardwood. A washer made from rubberized fabric belting was rounded and bolted to the cap (or back) by means of a long carriage bolt run through a longitudinally drilled hole in the centre of the bullet-shaped body. The overall length of this was approximately 5 in., with a diameter of 2 in. designed for operation in 2½-in. flow-lines. The diameter of the leather cap or scraper was such that small clearance was allowed between it and the pipe-walls. Experience proved this type susceptible to failure of the wooden body through cracking; also it was very light.

Eliminating the detriments of being too light and the possibility of cracking, one of the present type of go-devils used on this lease is constructed from 2-in. pipe; the nose made by slitting, bending, welding, and machining the pipe back to a finish. The leather wash-pipe is attached to the cap by means of a projecting bolt welded in the exact centre of the inside bullet shell. Aside from the metal construction, this has the same appearance as the wooden type.

A later design in use consists principally of three washers, spaced apart along a centre bolt, and held in position by a nut on the end. This type has weight, but not too much of it, has three concentric scrapers of increasing diameter such that the "bite" of paraffin load is distributed over each. Similar to the action of multiple piston rings on a cylinder, this increased number of washers should also provide greater resistance to leakage of the motivating gas past the go-devil. A. H. N.

982.* Factors Necessary for Consideration in Planning a Secondary-Recovery Development. R. C. Earlougher. *Oil Wkly*, 5.7.43, **110** (5), 19.—Before any secondary-recovery project is started, a thorough investigation should be made to determine the feasibility of such operations and also to decide on which type of operation—that is, gas injection or water-flooding—is to be used. Such a study is roughly divided into two parts. First, the preliminary investigation which has to do with the assembling of all available records and information concerning the property under consideration, and a thorough analysis and breakdown of such information. Second, if the preliminary study proves favourable, a detailed investigation should follow. This latter normally consists of obtaining new information—namely, the drilling of new wells and acquisition of cores of the producing formation and the subsequent detailed analyses and interpretations of results secured therefrom. If, from this detailed study, it is decided that secondary-recovery operations merit a test in the field, the operating plan should be set up, and preparations made for close and careful operating control during the life of the project.

Briefly, the preliminary investigation should cover the following points: (1) Past production records and history. (*a*) Initial production. (*b*) Sustained production. (*c*) Total primary recovery. (2) Water production from old wells. (3) Sand thickness and areal extent from old logs. (4) Condition of old wells. (5) Number and location of abandoned holes. (6) Gravity and viscosity of oil. (7) Water supply for flooding or gas supply for injection. (8) Market and selling price of oil. Each of these items is discussed.

In making a detailed study of a prospective area, the first step necessary is to secure a sufficient number of cores so as to obtain as nearly as possible an average picture of the producing formation. The chief factors to be determined from cores, and the resulting analyses are: (1) Net sand thickness. (2) Oil content in place in the sand as expressed as barrels/acre-foot, as well as total barrels/acre-foot. (3) Per cent. porosity. (4) Per cent. oil saturation expressed as percentage of the total pore volume. (5) Per cent. connate water expressed as percentage of the total pore volume. (6) Permeability. (7) Laboratory flooding tests. (*a*) Residual oil saturation after flooding. (*b*) Differentiation between floodable and non-floodable sand. (8) Net floodable sand thickness. Separate discussion is given for each of the eight items. Graphs and other details illustrate the important points. It is concluded that secondary recovery definitely is a speciality in itself, and in many ways entirely different from all other operations in the oil industry. If secondary recovery is to be applied, and to be successful, detailed and careful investigation should be made of any property before a project is commenced. Likewise, no one factor is sufficient to ensure the success of such an operation. As the best example, it has often been said that any property with a good past production history not in a water-drive field was adaptable for water-flooding; however, this is entirely too broad a statement. There are already several cases in which such properties have been subjected to flooding solely on that basis, and the result has been a failure. On the other hand, this factor of past production history is important, and should be considered. Likewise, a secondary-recovery project is not something to be turned over to some orphan department for a plaything. More often than not when such has been the case, the result has been a failure. Any water-flooding project should be a full-time job, and should be given every possible consideration. There are undoubtedly large oil reserves available which can be secured by secondary recovery methods; however, great expense and study will be required to obtain them, and at present this work is limited by the existing price of crude oil. A. H. N.

983. Construction and Operation of a Water-Treatment and Disposal Plant. Anon. *Oil Gas J.*, 8.7.43, **42** (9), 29–32.—In one well-known field from which oil has been produced in quantities for many years, the emulsion cut has gradually increased, until recently the pressure necessary to ship the oil required an average of 350 lb./sq. in. on the shipping pumps. The transfer line had been in service for many years, and had become thin because of wear and external corrosion, and the 350 lb. at the field end was about as high as could be maintained with any degree of safety. Two solutions of this problem were offered the executives of the company by the engineers. The first included laying a new pipe-line from the field receiving tanks to the distant treating-plant, and the installation of a battery of new shipping pumps. The solution, however, in reality solved nothing, except to remove the pipe-line leaking hazard from the system which, if put into operation, would still deliver wet, emulsified oil to the old treating plant. The second solution included re-vamping the entire gathering and flow-line system of the producing properties, the construction of an unattended flow-line treating plant on the property, and disposing of the separated water so that only clean pipe-line oil would be shipped to the pipe-line receiving station. The second suggestion is described in detail, with a flow diagram and photographic illustrations.

One of the most valuable auxiliaries of this oil-treating plant is represented by a complete, detailed flow diagram showing accurately—but not to scale—the location of each operating pipe-line, the tanks, dehydrators, heaters, separators, and each individual gate or block-valve and instrument, numbered on the print and described in a box at one side, so that an inexperienced operator can readily understand what is to be done. The valves, instruments, and regulators are shown on the diagram and numbered in operating sequence with tags on each wheel, or stem, in the order in which they are most frequently used, following through from the wet-oil gathering line to the

shipping pumps. The remainder of the valves are of somewhat minor importance to the operator, as the treating engineers usually put the plant into operation and make any necessary adjustment to overcome problems which the average pumper has not the time or training to handle. A. H. N.

984. Basic Principles of Reservoir Behaviour. Part 2. J. Zaba. *Oil Gas J.*, 8.7.43, **42** (9), 34.—Gas–oil and water–oil ratios are discussed. In measuring the gas–oil ratios, close attention to details is essential. Conditions of equilibrium must be assured and the rate of production at which the measurement was taken must be stated. Precautions must be taken that all gas produced is being measured. To avoid the confusion which frequently results from free use of term "gas–oil ratio," the term should be definitely qualified. Nomenclature has been suggested the use of which would eliminate the possibility of wrong interpretation. The following terms, which are self-explanatory, have been suggested: formation gas–oil ratio, formation gas–liquid ratio, circulated gas–oil ratio, gross gas–oil ratio, gross gas–liquid ratio, tubing gas–liquid ratio. The last two terms apply to pumping wells, and should be used when no gas from the annulus is included in the measurement.

Productivity index is defined and explained. The basic concept of the productivity index is simple, but the factors involved make it highly complex. For a homogeneous fluid flowing through the reservoir in a viscous radial flow under steady state conditions, the rate of flow would be proportional to the differential pressure. This may be expressed by the following equation: $Y = C(X - X_1)$, where Y = rate of flow, $X - X_1$ = differential pressure, C = constant of proportionality.

The constant C, the slope of the line, would be the productivity index, which would be constant for different rates of production. The reservoir fluid, however, is not homogeneous. It is an oil–gas mixture, the characteristics of which change as the liberation of gas takes place. The characteristics of the reservoir itself change as a result of changes in saturation. The flow in the proximity of the well may change from viscous to turbulent. The productivity index is therefore a function not only of reservoir and fluid characteristics, but also of oil–gas ratio, pressure differential, absolute reservoir pressure. From a purely theoretical standpoint, therefore, the productivity index would not be expected to be constant for different rates of production, which would limit its practical usefulness. Actual measurements, however, of the productivity index of a great number of wells showed that for moderate rates of production, and for conditions of equilibrium such as can be attained under practical field conditions, linear relation does exist in a large number of cases, between rate of production and pressure differential. In many other cases, deviation from this straight relation is well within the probable limits of error of measurements. Because of this fact, the productivity index found wide practical application as a measure of the productivity of wells. Different definitions used for productivity index and the specific productivity index are given, followed by general description of the methods used to measure them, and by a bibliography. A. H. N.

985. Repair of Corroded Casing Strings in Old Kansas Wells. N. Williams. *Oil Gas J.*, 8.7.43, **42** (9), 46–47.—Some of the methods being followed by Kansas producers in repairing corroded casing in old wells are presented in this article. Protection of pipe being run in new wells against corrosive waters is another important phase of operations now receiving attention.

Sources of the most corrosive water are the Arbuckle lime, the principal and deepest oil-producing horizon in the majority of fields of Western Kansas, and the Dakota sand, a shallow horizon which has been unproductive of oil to date. Arbuckle water, produced with the oil, attacks the casing from within the well. Corrosion from water in the Dakota sand and other shallow formations results when this water acts on the casing from behind, causing leaks that permit the water to get into the well. Corrosion by Arbuckle water inside the well can be controlled to a large extent by production methods. Casing failures due to Arbuckle water corrosion have been chiefly in wells that have been pumped up the hole with tubing and pumps set high enough to permit "skimming" the oil. By setting the tubing and pumps near bottom, and pumping from the bottom of the hole, the amount of casing with which water comes in contact is usually small, since ordinarily oil fills the annular space behind the tubing above the

pump intake. Few casing failures from Arbuckle water corrosion have occurred in wells that have been pumped from the bottom, and this is now general practice.

Squeeze cementing jobs have been undertaken in quite a few wells with a fairly high percentage of success. Through perforations above and below leaking sections sufficient cement is squeezed behind the pipe to fill the annular space through the section and for some distance above and below, providing not only a water shut-out, but also a protective encasement behind the pipe. Squeeze jobs also have been resorted to frequently to get cement behind the pipe through the Dakota sand in wells in which surface casing was not set and cemented through that formation. Other methods are given, such as using new casings or using liners. A. H. N.

986. Patents on Production. D. Brookshire. U.S.P. 2,319,295, 18.5.43. Appl. 12.8.41. Well-packer with a working barrel section.

G. W. McCullough. U.S.P. 2,319,336, 18.5.43. Appl. 22.8.41. Regulating mechanism for valves.

W. W. Drinkard. U.S.P. 2,319,493, 18.5.43. Appl. 20.5.40. Retractable formation sealing tool with a valve.

C. A. Moon. U.S.P. 2,319,702, 18.5.43. Appl. 4.4.41. Method and apparatus for producing oil-wells.

I. S. Salnikov. U.S.P. 2,319,749, 18.5.43. Appl. 22.7.41. Bore-hole pump by hydraulic means.

C. H. M. Roberts. U.S.P. 2,319,885, 25.5.43. Appl. 8.10.40. Process and composition for treatment of emulsions of oil in water.

J. P. Walker. U.S.P. 2,319,962, 25.5.43. Appl. 24.6.40. Method of and means for treating and/or dehydrating oil, gas, and water mixtures, such as flow from oil-wells.

G. Raymond. U.S.P. 2,320,447, 1.6.43. Appl. 3.10.40. Device for determining flow volume of treating liquids flowing into a well.

C. P. Walker. U.S.P. 2,320,492, 1.6.43. Appl. 11.8.38. Method of determining fluid pressure and production capacity of oil-wells.

F. A. Guetjen. U.S.P. 2,320,589, 1.6.43. Appl. 28.4.41. Packing assembly to surround a reciprocating rod.

D. L. Mitchell, H Marks, and H. C. Beene. U.S.P. 2,320,633, 1.6.43. Appl. 16.11.40. Water-sealing composition for oil-wells.

C. M. O'Leary. U.S.P. 2,320,646, 1.6.43. Appl. 13.12.40. Rod-catcher.

T. J. Steward. U.S.P. 2,320,673, 1.6.43. Appl. 3.8.40. Well-treating fluid comprising an acid of the formula HSO_3–*A*–*R*–*A*–SO_3H, where *A* is a bivalent aromatic radical and *R* is a bivalent aliphatic radical.

L. Yost. U.S.P. 2,320,708, 1.6.43. Appl. 22.11.40. Submersible electrically driven pump.

A. Boynton. U.S.P. 2,321,002, 8.6.43. Appl. 8.12.39. Stage lift-flow device comprising a side-valve.

A. Boynton. U.S.P. 2,321,003, 8.6.43. Appl. 8.12.39. Differential stage lift-flow device.

T. B. Wayne. U.S.P. 2,321,056, 8.6.43. Appl. 29.7.38. Process and reagent for resolving emulsions.

J. H. Wiggins. U.S.P. 2,321,058, 8.6.43. Appl. 1.11.40. Floating roof for liquid storage tanks.

J. J. Grebe and L. C. Chamberlain. U.S.P. 2,321,138, 8.6.43. Appl. 2.5.38. Treatment of fluid pervious formations.

H. B. Lee. U.S.P. 2,321,215, 8.6.43. Appl. 5.10.40. Safety coupling for sucker-rods.

C. H. Mathis and C. Rampacek. U.S.P. 2,321,761, 15.6.43. Appl. 5.8.40. Process for plugging formations.

O. Barstow. U.S.P. 2,321,970, 15.6.43. Appl. 28.8.40. Method and apparatus for treating wells for injecting fluid simultaneously into at least two zones.

A. H. Brandon. U.S.P. 2,322,343, 22.6.43. Appl. 14.10.40. Tubing wear detector using feelers.

L. L. O. Cranford. U.S.P. 2,322,419, 22.6.43. Appl. 18.9.40. Paraffin scraping tool for wells.

H. H. Kaveler. U.S.P. 2,322,453, 22.6.43. Appl. 23.9.40. Apparatus for controlling oil-wells.

Q. F. Wirtel and C. M. Blair. U.S.P. 2,322,494, 22.6.43. Appl. 27.4.42. Process for breaking petroleum emulsions.

B. M. Davis. U.S.P. 2,323,085, 29.6.43. Appl. 7.11.40. Retrievable combination bridge plug and packer. A. H. N.

Transport and Storage.

987. Calibration of Horizontal Cylindrical Tanks. H. David. *Oil Gas J.*, 4.3.43, **41** (43), 49.—Given a tank of perfectly cylindrical form laid horizontally, it is obviously possible to calculate the volume of liquid which it contains from a knowledge of the depth of oil and the radius and length of the tank. From calculated data a graph is presented which enables a volumetric coefficient to be read off after determination of the ratio of the measured depth of oil to the known diameter of the tank. This volumetric coefficient (C) is such that the quantity of oil (Q) in gallons (U.S.) can be determined directly by the formula $Q = C \times L \times R^2$, where L is the length of the tank in inches and R is the radius of the tank in inches.

The use of the graph reduces the amount of calculation required, but the accuracy will be affected by inclination of tank, presence of piping, baffles, etc., in the tank, accumulation of b.s. and w. and spherical ends of the tanks. R. A. E.

988. Transportation Problems of the Oil Industry. S. A. Swensrud. *Petrol. Tech.*, July 1943, **6** (4); A.I.M.M.E. Tech. Pub. No. 1610, 1–11.—In peace-time the transportation of petroleum and its products attracts little attention among those not intimately concerned with it, but the war has brought to the fore the tremendous importance of this problem. The construction of the 24-in. war emergency pipe-line now raises new questions regarding the relative merits of large-diameter pipe-lines and tankers, and focuses attention on the reasons why tankers originally displaced pipe-line transportation, which was then much more costly.

In product transportation the change from tank-cars to trucks and product pipe-lines is merely a speeding up of a process which has been under way for many years, due largely to the railway companies' inflexible attitude regarding rates. The transportation of products by pipe-line was delayed by other factors long after it became a practicable proposition.

The effect of transportation changes on marketing operations is profound. The development of pipe-line and other means of transport has been greatly aided by the integration of the oil industry, which gave the advantage of low incremental costs to large companies controlling a sufficient volume of oil to utilize the new forms of transportation. The war-time shift from tanker to rail transportation has been done well, but could have been effected more rapidly had there been a better appreciation of the possibilities of tank-car substitution and an earlier concentration on the moving and unloading of tank-cars in trainload lots. In the joint use of facilities the rapid attainment of 70–80% of the theoretical possibilities is probably preferable to the delays

involved in the formulation and administration of complicated plans which will give 100% efficiency from the start. The post-war use of the large pipe-lines will be a big problem, and the same is true of the extra barge facilities which have been created.
G. D. H.

Cracking.

989. Phillips Cycloversion Process. Anon. *Oil Gas J.*, 4.3.43, **41** (43), 41.—The main object of the process is to convert naphthas produced in thermal cracking operations into stocks rich in aromatics and suitable for incorporation in aviation gasoline.

Aviation gasoline fractions containing up to 90% of aromatics with very small amounts of olefins may be obtained, and the principal by-products include butylene and *iso*butane. After laboratory and pilot-plant investigations, a new unit has been installed at one of the company's refineries. In the course of studying variables the unit has been operated on stocks ranging from light gasolines to heavy gas oils. For aviation-stock preparation, excellent results have been obtained by processing selected naphthas derived from gas oil or topped crude thermal cracking, or from gas reversion operations. The operating conditions of temperature, pressure, concentration, contact time, and cycle length can be varied to suit the type and boiling range of the charge stock. A fixed catalyst bed is installed in the reactors, reactivation being accomplished by controlled burning of the accumulated carbonaceous matter. Steam is used in both process and reactivation stages without injury to the catalyst, which is said to be able to withstand high temperatures and to have a long life. The process is made continuous by alternate use of two or more catalyst chambers. The length of the process period ranges from 1 to 5 hrs. when producing aviation stocks, according to the characteristics of the charge stock and the desired depth of conversion. The unit is illustrated.
R. A. E.

990.* Fluid Catalyst Cracking of Petroleum. E. V. Murphree, C. L. Brown, H. G. M. Fischer, E. J. Gohr, and W. J. Sweeney. *Industr. Engng Chem.*, 1943, **35** (7), 768.—A simplified flow diagram of a fluid catalyst cracking plant is presented and a description of the process is given. Several different methods of operating this process are discussed, in which motor and aviation fuels are obtained as direct products. Other methods of operating this process to produce aviation grade products are to hydrogenate the crackate or to employ the catalytic cracker as a means of producing *iso*butane and butylenes for subsequent alkylation. Typical analyses of products produced by these various processes are given.

Applications of the fluid catalyst technique to processes other than cracking are discussed, and it is shown that this is a process which is particularly advantageous where close temperature control is required, since the solid suspension imparts heat capacity to the vapours.
J. W. H.

991.* Thermal and Catalytic Decomposition of *cyclo*Hexane at High Pressures. V. Haensel and V. N. Ipatieff. *Industr. Engng Chem.*, 1943, **35** (6), 632.—The thermal decomposition of *cyclo*hexane has been examined in a continuous-flow system over the temperature range 500–540° C. at 100 atmos. pressure. Catalytic cracking with an alumina catalyst has been examined over the temperature range 550–578° C. at pressures of 44–140 atmos. in the same system as was used for the thermal decomposition experiments. Detailed analyses of the gaseous and liquid products in terms of chemical types and compounds are given, and from these data a mechanism of the decomposition reaction has been put forward.
J. W. H.

Polymerization and Alkylation.

992. Facts About and Possibilities of Alkylation and Isomerization Processes. A. L. Foster. *Oil Gas J.*, 15.4.43, **41** (49), 77.—Commercial application of both these processes to the petroleum industry is a comparatively recent development, but the importance of both is expected to increase not only during war-time but also in the

post-war period. It is not possible to forecast the specifications which will be required of the motor and aviation fuels of the future. The importance which has been attached to volatility, especially in the natural gasoline industry, may, for example, be minimized by changes in engine design, in particular the possibility of solid injection of the fuel. One factor which can be counted upon with certainty is that anti-knock value will become of even greater importance than it has been in the past. It is therefore considered that the fuels of the future will tend increasingly to become blends of selected products manufactured by a variety of processes designed to enhance the natural anti-knock value of gasolines, and including alkylation and isomerization.

After a brief review of some of the principal methods employed in alkylation and isomerization at the present time and discussion of the general properties of some of the products, consideration is given to the future application of the processes and the potential production of alkylates obtainable from the light hydrocarbons available from natural gasoline and liquefied petroleum gas sources. Application of the isomerization process to low-grade refinery naphtha and low-octane-number natural gasoline residues may be economic, and perhaps necessary in order to convert the raw materials into marketable components. A combination of the two processes may effect changes in the utilization of natural gasoline, which may well become the source of raw materials for the processes. For example, the following scheme is a possibility: (1) Separation of *iso*paraffins by fractionation; (2) isomerization of the remaining *n*-paraffins, in different fractions or all in a single charge, (3) disposal of the isomeric products, part as charge for alkylation plants and the heavier portions as finished blending stock for motor or aviation fuels. R. A. E.

993.* Separation of Individual Cresols and Xylenols from Their Mixtures. D. R. Stevens. *Industr. Engng Chem.*, 1943, **35** (6), 655.—Considerable difficulty is encountered in the separation of these compounds by distillation owing to the closeness of the boiling points. It is shown that if these compounds are alkylated with *iso*butylene, the tertiary butylated phenols may be easily separated, and the products debutylated to yield *iso*butylene and the individual phenol. J. W. H.

Refining and Refinery Plant.

994.* Portable Heater for Preventing Hydrate Formation. J. C. Albright. *Petrol. Engr*, November 1942, **14** (2), 52.—A short description is given of a heater designed to raise gas temperatures in high-pressure gas streams sufficiently to prevent hydrate formation. The installation resembles a small oil-field-type boiler, is portable, burns gas, and uses a reservoir of water to prevent excessive heating of the pipe-line, which would lead to deterioration and corrosion. J. C.

995. Pilot-Plant Study of the Gray Clay Treating Process. A. W. Cobb and L. Carlson. *Oil Gas J.*, 19.11.42, **41** (28), 33.—The widely used Gray vapour-phase clay-treating process for improving colour and gum stability of cracked gasoline gives more economical operation on a refinery scale than is obtained on small-scale laboratory apparatus. Consequently, conversion factors have been in use to project to the experimental plant results the laboratory results obtained with a small catalyst bed. To get a more exact method of evaluation a pilot plant has been developed.

The experimental unit described was installed close to a large plant-cracking equipment, took vapours direct from the line leading to the plant Gray units, and consisted of two complete clay-treating systems, each having its own after-fractionater, condensers, and receiver. The double system allowed observation of the effect of altering single variables such as catalyst, time of contact, etc. A flow diagram and detailed description of the pilot plant are given. Tabulated data indicate not only excellent correlation with large-scale plant and the usual improvements in gasoline quality associated with Gray treating, but also show that the process has no deleterious effects on octane number. J. C.

996. Trend Towards More Precise Fractionation Accelerated in Natural-Gasoline Plants. H. S. Norman. *Oil Gas J.*, 15.4.43, **41** (49), 109.—The annual survey of natural-gasoline plants given on p. 113 indicates clearly that there is an accelerating

trend towards closer fractionation of the light hydrocarbons. It is considered that this is not merely a measure designed to meet war requirements, but that prospective post-war demands will increase the rate of installation of the necessary plant. In fact, shortage of critical materials and the retarded rate of new oil-field discoveries have probably delayed the rate of construction of plants during the war period. A table shows the distribution of natural gasoline plant capacities in 1943 among the various States; in total there are 567 plants with a daily natural gasoline capacity of over 11½ million gals. 154 of these plants were equipped to recover liquefied petroleum gases, an increase of fifteen plants over 1942. The daily capacity of the recovery plants was over 3½ million gals., an increase of about ½ million gals. a day over 1942. Bureau of Mines statistics indicate production in 1942 of 118 million gals. of *iso*butane and 674 million gals. of liquefied petroleum gases at natural gasoline and cycling plants and 192 million gals. of liquefied refinery gases at refineries.

Increasing volumes of butane are moving to isomerization plants, and *iso*butane is being segregated for alkylation plants wherever practicable. Whilst the demand for butanes for special purposes continues, greater emphasis may be placed on the recovery of propane in natural-gasoline plant operations. The survey of natural gasoline plants shows the name of the operating company, the plant location, the daily capacity in gals., and the daily capacity for liquefied petroleum gases where such plant is also installed. Plants are grouped alphabetically under the state in which the plant is operated and the name of the operating company. R. A. E.

997. Practical Design and Economics of Cathodic Units Applied in a Refinery. D. Holsteyn. *Refiner*, June 1943, **22** (6), 179–182. *Paper Presented before Petroleum Industry Electrical Association (America).*—To give some idea to those not familiar with them, of an oil-refinery layout and its intricate pipe-line system, an area 1 mile square, half of which is taken up by storage tanks and the other half occupied by the refinery units and equipment, storehouses, workshops and offices, is studied. Steel approximately equivalent to 600 miles of 4-in. line is buried in this small area. These lines, varying in size from ½ in. to 36 in. in diameter, fan out in all directions at different elevations, crossing and paralleling each other at distances from several feet to less than ½ in. They carry crude oils, various petroleum products, water, air, gas, chemicals, at different temperatures. Except for a few cases, the lines are laid without a protective coating.

The soil conditions throughout a refinery vary a great deal. Chemical spills, leaks in acid lines, seepage from refinery sewers and sludge-pits, all affect soil characteristics. Measured with the Shephard canes, this soil may show a resistivity of 5000 ohms per c.c. at one point, and a few feet away may measure as low as 100–200 ohms per c.c. The p_H value of the soils may vary from 2·8 to 9·0. Moisture content may be as high as 45%. Thus, the corrosion engineer engaged in cathodic protection is confronted with many variables in approaching his problems. The consensus of opinion among corrosion engineers is that when the potential difference, measured in volts, between the pipe and a copper sulphate electrode in contact with the soil adjacent to the pipe measured 0·85 volt negative, complete protection is accomplished. Details of design are given.

It is assumed that: (*a*) The average life of an unprotected line under more than normal corrosive soil is seven years. (*b*) The life of a protected line under same conditions is 26 years. (*c*) The cathodic unit life is 10 years and the installation cost/unit is an average of $1000. (*d*) Average protection of 10,000 sq. ft. of pipe surface/unit at an operating cost of $175/year, including supervision, renewal of ground-bed, and power cost. (*e*) The average price/sq. ft. of pipe installed is $1·35. This figure may differ from the extreme, depending on working conditions in hazardous areas and areas congested with underground piping. The calculated savings per month with protection is $94·53/sq. ft., and payout period is 10·6 months. A. H. N.

998. Reclamation of Cracking Still Furnace Tubes. L. V. Hile. *Refiner*, June 1943, **22** (6), 183–187.—A detailed and practical exposition of the reclamation of some 200 used 4–6% chrome, 0·5% molybdenum, 4 × 5-in. furnace tubes by arc welding is given. A. H. N.

999.* War Developments in the Petroleum Industry. E. V. Murphree. *Industr. Engng Chem.*, 1943, **35** (6), 623.—Brief reviews are given of the following processes: Super-

fractionation, alkylation, isomerization, hydroforming, catalytic cracking, butadiene production, and the manufacture of special products. J. W. H.

1000. Isomerization—A Useful but as yet a Little Used Tool for the Refiner. A. L. Foster. *Oil Gas J.*, Part I, **41** (42), 66; Part II, **41** (43), 51.—Although patents dealing with isomerization of specific olefins and groups of hydrocarbons were issued in European countries as early as 1912, it is only within the last decade that the application of isomerization to the production of motor and aviation fuels and their components has been developed on a commercial scale. In the first instance, isomerization was utilized as a means of converting part of the large quantities of *n*-butane available in refineries and natural gasoline plants to *iso*butane as an adjunct to alkylation, since usually there is insufficient *iso*butane from other sources in any individual plant to meet the requirements for alkylation of the butenes available. Three of the catalysts used with success on the commercial scale for alkylation are sulphuric acid, anhydrous aluminium chloride, and anhydrous hydrofluoric acid. The last two mentioned are also effective isomerization catalysts, and it appears feasible to employ either in a combination of isomerization followed by alkylation, using the same catalyst under somewhat different conditions for each step in turn. One or other of the processes using these catalysts is now building or operating in a large number of refineries in the U.S.

In the last five years three commercially successful isomerization processes have been developed: (1) The Shell Development Co. Process, which utilizes $AlCl_3$ or a complex formed by $AlCl_3$ and aromatic or other hydrocarbons, and a hydrogen halide; (2) the Standard Oil Co. of Indiana, or "isomate" process, which employs anhydrous $AlCl_3$ and a promoter such as HCl; (3) the Universal Oil Products Co. process employing metallic oxides or $AlCl_3$ and HCl. References to some of the patents concerned are given. These processes use nominal pressures and temperatures up to 300° F., conditions mild enough to warrant the assumption of low costs and relatively inexpensive equipment. Other companies—*e.g.*, Texas Co. and Standard Oil Development Co.—have also been active.

The patents reveal two fields of application of the isomerization process: (1) The improvement in quality of low-grade distillates by increasing *iso*paraffin content; (2) changing the configuration of individual hydrocarbons. The former has a definite and potentially important place in motor and aviation fuel technology. Low-grade distillates have been raised to 65–70 octane rating according to claims made, and it appears reasonable to believe that specially selected stocks may yield products suitable for blending into aviation gasolines and special military fuels of 80 octane or over, under suitable conditions of treatment. Such a method may have advantages over thermal refining or catalytic cracking or re-forming in respect of lower costs and product loss. Since the higher-molecular-weight hydrocarbons tend to split during the isomerization process into hydrocarbons of lower molecular weight, an increase in vapour pressure and volatility accompanies the octane rating increase. A table indicates octane ratings of several *iso*paraffins compared with their normal isomers.

As regards the second field of application, details are given of the isomerization of *n*-pentane, *n*-heptane, *n*-octane, and *n*-hexane, and of the effects of conditions on the yield of products from these hydrocarbons. Synthesis of the heavier *iso*paraffins, such as triptane and 2 : 2–3 : 3-tetramethylpentane, both desirable on account of high anti-knock properties, may prove to be simpler by a combination of isomerization and alkylation rather than isomerization alone. Recently the preparation of neo-hexane catalytically by a special adaptation of the "isomate" process has been announced. Theories of the mechanism of the isomerization reaction are briefly outlined, and future possibilities in respect of products other than engine fuels are discussed. R. A. E.

1001. Hydrogen Fluoride—The Catalyst. Part 1. J. H. Simons. *Refiner*, June 1943, **22** (6), 155–161.—This part deals with the physical and chemical properties of hydrogen fluoride. The history of preparing this compound is discussed. The industrial method of preparing the compound consists of a carefully controlled reaction between calcium fluoride (fluorite or fluorspar) at an elevated temperature, followed by a distillation of the gaseous products. In this process steel equipment is used throughout. The liquefied gas is stored in steel storage tanks. Pipes, fittings, and valves are all made of steel (ordinary, not stainless). The commercial material contains less than 0·5% water, the average being 0·1–0·2%. Silicon fluoride is less than 0·1% and often as low

as 0·01%. It contains a small amount of sulphur dioxide which can be removed if required.

A general study of the properties of hydrogen fluoride shows it to be more akin to water and ammonia than to the other halides. Its physical properties give it considerable technical advantages over many other substances for similar large-scale industrial use. Its low formula weight, 20, gives it more effective chemical/pound than any other catalytic agent for use in the same reactions. This, of course, results in smaller and lighter equipment. As it freezes below solid carbon dioxide temperature, there can be little need for handling it as a solid. Its boiling point is conveniently near room temperature, and it can thus be handled as either a liquid or a gas without the need of using either high temperature or pressure. At 100° F. the vapour pressure of the liquid will give a gauge pressure of only about 15 lb./sq. in. The density of the liquid is close to that of water at the same temperature, and it is thus more dense than most hydrocarbon material. It has a very low surface tension. This, plus the high density, enables the liquid to mix readily with hydrocarbons by agitation, but at the same time allows the mixture to separate readily and easily by settling. It shows little tendency to foam. Pipe and tubing of small diameter can be used, as the viscosity of the liquid is low. The author has measurements of the viscosity in progress at the present time, and these will be published in the near future. The use of the fluoride as a solvent is discussed in detail, followed by a study of its electrical properties and its possible molecular structure.

Hydrogen fluoride is an extremely powerful acid, even more powerful than nitric acid. Despite this it is an apparently weak acid in aqueous solutions, where its apparent acidity is comparable with acetic acid. An explanation of this is given in an article in *Chemical Reviews*, 1931, **8**, p. 213. It is also an extremely powerful dehydrating agent. There is, in fact, no drying agent which either does not react with it or which will remove water from it. It must be made dry. It removes water from sulphuric acid and reacts with phosphorous pentoxide to form water. Despite this it does not dehydrate primary alcohols at ordinary temperatures, nor does it dehydrate acetone anything like so rapidly as sulphuric acid does at the same temperature. It shows a great tendency to form molecular complexes, as shown by the study of the potassium fluoride–hydrogen fluoride complexes by Cady. He lists KF·HF, KF·2HF, 2KF·5HF, KF·3HF, and KF·4HF. With water the complexes H_2O·HF, H_2O·2HF, and H_2O·4HF have been found. The stability of some of these complexes is very great. A large amount of heat is evolved on mixing hydrogen fluoride and water. The same is true on mixing hydrogen fluoride and sodium or potassium fluoride. The strength of the potassium fluoride–hydrogen fluoride complex is shown by the fact that it will produce by decomposition 1 atmosphere pressure of hydrogen fluoride only at 504° C. It should be pointed out that the existence of the salts KF·HF and NaF·HF does not mean that the acid is dibasic. It is not, and the " so-called " bifluorides are merely salts with hydrogen fluoride of crystallization. Hydrogen fluoride forms highly coloured molecular complexes with many organic chemical compounds such as phenols. It has a strong adhesion to many substances such as metals, oxides, minerals, etc., even those with which it does not readily react. A. H. N.

Chemistry and Physics of Hydrocarbon.

1002. Determination of High-Pressure Vapour-Liquid Equilibrium. J. Griswold, D. Andres, and V. A. Klein. *Refiner*, June 1943, **22** (6), 171–178.—Previous methods of measuring equilibria at high pressures are indicated. A description, with illustration, of the apparatus used by the authors then follows. The chief points of interest are: (1) A circulation-pipe and collar in the heater section, to insure adequate mixing of condensate and still liquid before the vapour is released from the boiling liquid. (2) Ample vapour space above the boiling liquid, so that entrainment is negligible. (3) A condenser constructed in several sections, so that condensing surface as well as type of cooling fluid may be altered to suit the system and the temperature level. (4) A ball-check valve in the condensate return line to prevent back-surges during momentary fluctuations of heat input or removal, or while withdrawing samples. The back pressure caused by this valve maintains a higher liquid level in the condensate chamber

than in the still, hence the valve design fixes the vertical position of the condensate chamber with respect to the still.

Many of the parts may be made from extra-heavy and double-extra-heavy pipe. All pressure outlets, small connecting lines, and the two thermo-wells are made from ¼-in. extra-heavy-pipe. All direct pipe connections on the apparatus are welded in place. The operating procedure in obtaining liquid and vapour samples under equilibrium conditions is described. The equilibria of benzene–toluene systems at different temperatures and pressures are given in full. A. H. N.

1003.* **Heat Capacities of Hydrocarbon Gases.** D. R. Stull and F. D. Mayfield. *Industr. Engng Chem.*, 1943, **35** (6), 639.—The Bennewitz and Rossner method of calculating gaseous heat capacities from spectroscopic data has been extended to a wider temperature range. Tables of solutions to the Einstein function for one degree of freedom and bonding frequency contributions to the molar heat capacities are presented. By the new method the heat capacities of 29 hydrocarbons over the temperature range 250–1500° F. have been evaluated and compared with previously published data. The results show an average difference of ±4%. J. W. H.

1004.* **Equilibrium Still for Miscible Liquids.** C. A. Jones, E. M. Schoenborn, and A. P. Colburn. *Industr. Engng Chem.*, 1943, **35** (6), 666.—A detailed description is given of an all-glass simple apparatus for the determination of the vapour–liquid equilibria for miscible liquids. Experimental data are given for the systems ethylene dichloride–toluene and ethanol–water. From the results obtained it is shown that the former system closely obeys Raoult's Law. J. W. H.

1005.* **Correlating Fluid Viscosity.** A. S. Smith and G. G. Brown. *Industr. Engng Chem.*, 1943, **35** (6), 705.—An attempt to apply the theorem of corresponding states to the determination of gaseous and fluid viscosities has shown that it cannot be generally applied, but the correlation is of value in the case of closely related groups of compounds. Experimental determinations of the viscosity of ethane and propane in the range 100–5000 p.s.i. and 15–200° C. have been made, and a plot is presented for the normal paraffin hydrocarbons and their mixtures which enables the viscosity data in this series to be extended for reduced pressures up to 10 and reduced temperatures from 0·65 to 1·5 with the accuracy of the experimental data used in the correlation. J. W. H.

1006. **Breakdown of Thixotropic Structure as Function of Time.** R. N. Weltmann. *J. Appl. Phys.*, July 1943, **14** (7), 343–350.—Measurements of the thixotropic breakdown of structure, with time of agitation, were performed at different rates of shear on a number of pigment suspensions and on various oils in a rotational viscometer. The product of rate of breakdown in thixotropic structure and time of agitation at any rate of shear was found to be a constant for each material. It is called "the time coefficient of thixotropic breakdown," and is independent of the rate of shear, which is applied to agitate the sample. The time coefficient of thixotropic breakdown is measured in absolute units, having the dimensions of viscosity (dynes sec./cm.²). The equilibrium time—the time necessary to break the thixotropic structure down to its minimum at a specified rate of shear—was also found to be independent of the rate of shear applied while agitating.

Briefly, the following has been found experimentally. In a Couette-type viscometer, the viscosity as calculated by Reiner's formulæ, where yield values are found, gives a straight line when plotted against log time of rotation at constant values of rate of rotation. Further, such lines plotted for different rates of rotation are parallel, and all end in asymptotic but different values of equilibrium viscosities, independent of time, each being a function of rate of shear. Combining these facts, the difference between the value of the viscosity μ at any time t and the equilibrium viscosity μ_E for any rate of shear, fall on a unique straight line for the substance when plotted against log time of rotation—*i.e.*,

$$\log_e\left(\frac{t_1}{t_2}\right) = \frac{(\mu_1 - \mu_E) - (\mu_2 - \mu_E)}{B} = \frac{\mu_1 - \mu_2}{B}$$

where *B* is " the time coefficient of thixotropic breakdown " and is found independent of rate of shear or time of shearing. Of course, after equilibrium time is attained the viscosity is constant and this formula breaks down—apparently discontinuously.
A. H. N.

1007.* Viscosities of the Methane–Propane System. L. B. Bicher and D. L. Katz. *Industr. Engng Chem.*, 1943, **35** (7), 754.—Experimental data are given for the viscosities of mixtures of methane and propane over the pressure range 400–5000 p.s.i. and at temperatures between 77° and 437° F. A correlation of the data in terms of the theory of corresponding states shows that the average deviation is not greater than 2·9%, and that the corresponding state relationship may be used to obtain the viscosity of any light paraffin hydrocarbon with an average error of 3·5%. J. W. H.

1008.* Catalytic Chemistry. A. V. Grosse. *Industr. Engng Chem.*, 1943, **35** (7), 762. —The scope of catalytic chemistry is reviewed, and the present state of knowledge discussed in terms of broad principles. J. W. H.

1009.* Correlation of Aliphatic Hydrocarbon Densities in the Critical Region. T. G. Stevenin and J. G. Allen. *Industr. Engng Chem.*, 1943, **35** (7), 788.—A simplified correlation of the densities of paraffin and, to a limited extent, olefin hydrocarbons is presented which is based on the theorem of corresponding states. The data are presented in the form of a graph, and it is shown that the calculated data agree to within 2–5% of the experimental values. J. W. H.

1010.* Composition of the Dew-Point Gas in the System Ethane–Water. H. H. Reamer, R. H. Olds, B. H. Sage, and W. N. Lacey. *Industr. Engng Chem.*, 1943, **35** (7), 790. —Experimental data are given for the composition of the dew-point gas of the ethane–water system over the range 100–460° F. and at pressures up to 10,000 p.s.i.

These data are compared with similar data obtained on the systems water–methane and water-nitrogen. J. W. H.

1011.* Relative Volatility Calculations. Correspondence by R. Edgewoth-Johnstone and J. Griswold. *Industr. Engng Chem.*, 1943, **35** (7), 826.—The correspondence extends the formula put forward by J. Griswold (*ibid*, 1943, **35**, 247) by the presentation of a formula which enables the value of the relative volatility of wide boiling hydrocarbon systems to be calculated from a knowledge of the boiling points.
J. W. H.

Synthetic Products.

1012.* How an Alkyl-Rubber Plant Works. Anon. *Nat. Petrol. News*, 2.6.43, **35** (22), 18.—The article gives a semi-technical description of one of the Rubber Reserve Co.'s plants for the preparation of Buna S. The rated capacity of the plant is 90,000 long tons p.a. The works comprises 4 butadiene units and 2 styrene units delivering their products to the copolymer unit. Butadiene is prepared from fermentation alcohol, the nature of the catalyst being undisclosed. 98·5% purity is achieved by distillation and washing. In the preparation of styrene benzol and ethylene are passed over a catalyst and the resulting ethyl benzene is dehydrogenated to styrene. An aqueous emulsion of 3 parts butadiene and 1 part styrene is polymerized catalytically, the resultant latex being coagulated by treatment with acid and salt. The final product is recovered by screening, washing, squeezing, and drying. A few relevant statistics are furnished. H. G.

1013.* The Second Mile. L. B. Sebrell. *Industr. Engng Chem.*, 1943, **35** (7), 736.—A review is given of the technical progress which has been made in the development of synthetic rubber. Particular attention is given to the comparative physical properties of natural and synthetic rubbers. J. W. H.

Analysis and Testing.

1014.* Servicing Recording Calorimeter Used to Determine Heating Value of Gas. R. O. Cox. *Petrol. Engr*, September 1942, **13** (13), 69.—The theory of the C-H Thomas Recording Calorimeter is discussed. The instrument consists essentially of a tank unit or calorimeter wherein the heating value of the test gas is measured by imparting to a stream of air all the heat given by its combustion and measuring the rise in temperature of the air. The air and gas are initially brought to the same temperature by means of a common water-bath, and are kept in fixed proportion by motor-driven geared metering devices. A recorder unit translates the heat measurements into B.Th.U.'s and records them graphically.

Calibration of the instrument with hydrogen, methods of applying moisture allowances, and the general testing and maintenance arrangements used by the Lone Star Gas Co. are described. J. C.

Motor Fuels.

1015.* Oil Industry has Met the Problem of 100 Octane Gasoline. O. W. Willcox. *World Petrol.*, December 1942, **13** (13), 54.—A non-technical article which claims that of all American basic industries the petroleum industry, under the leadership of the O.P.C., has carried furthest general collaboration, including pooling of material resources and exchange of technical knowledge. The successive stepping up of the demands for 100 octane fuel since 1940 and the methods for keeping production ahead of the demand are discussed, success being ascribed to increased plant capacity and development of new processes such as catalytic cracking, isomerization, alkylation, precision fractionation, etc., leading to tremendous increases of yield for a given amount of crude. Confidence is expressed that the industry will be able to carry whatever new burdens are imposed, provided the required engineering materials are allocated. J. C.

Special Products.

1016. Organic Loading Fillers as a Substitute for Rubber. T. R. Dawson, R. C. W. Moakes and R. G. Newton. *Industr. Chemist*, February 1943, **19**, 80. *Paper read before the Institution of the Rubber Industry, London, Jan. 11th*, 1943.—Organic materials used as extenders for rubber include (*a*) non-standard substitutes, (*b*) fibrous fillers, and (*c*) hydrocarbon extenders. In class (*a*), in addition to vulcanized oils, a very wide variety of products have been suggested (see Pearson "Crude Rubber and Compounding Ingredients," 1920), some of which may be of interest in view of the rubber shortage. An example is given of "Resinolines" invented by E. Cadonet of Paris and prepared by saponifying various oils by the use of a metallic carbonate (preferably lead), decomposing with nitric acid, decanting, and saturating with an alkali. The soap is resinified with acid and purified by alcoholic extraction. The resins are remarkably flexible, and are similar to natural resins.

Fibrous fillers include fabric and fibre cuttings, wood-flour and shavings, coconut shells, cork dust, ground carbonized peat, and waste leather. These may be used where loss of elasticity is not important, as in floorings, soles and heels, etc., but are variable in quality because of difficulties in vulcanization, and reduce tensile strength. They are of value as reinforcing fabric, bonded products, and as cores for rubber articles, saving a high proportion of rubber. Hydrocarbon extenders (asphalt) were considered by Hancock in his original patent B.P. 9952/1843, and L. Wray in B.P. 2270/1858 included mineral caoutchouc (Elaterite) in an electric insulating composition. Mineral rubber is normally used to the extent of 5–10% on natural rubber without appreciable effect on the mechanical properties and assisting in processing. At present 30–40% is added, giving useful products, and even up to 60% has been used where loss of strength is not a serious factor. Other industrial pitches and resins have been tried in the past, but pine tar, used as a softener and tack producer, is the only product to become established. The best known of present extenders are the Naftolens, which consist of aromatic hydrocarbons of boiling range 200–380° C., obtained from mineral-oil acid tars. They are unsaturated, having a probable general formula $(C_2H_4)_n$, and are capable of being vulcanized. C. L. G.

1017. Vinyl Copolymer Resin for Air Drying Coatings. Anon. *British Plastics*, April 1943, **14**, 647.—Vinyl copolymer resin V.M.C.H. produced in experimental quantities by Carbide & Carbon Chemicals Corporation, is an improved vinylite resin which gives satisfactory adhesion over impervious surface and good chemical resistance when air dried, stoving at relatively high temperatures being necessary when using previous types. It should be particularly useful on all kinds of maintenance work or on entire industrial buildings and equipment exposed to corrosive atmospheres—*e.g.*, petroleum storage tanks. Air-dried coatings on magnesium or aluminium alloys are particularly resistant to salt water. Coatings on paper improve the adhesion of oil-base inks, and blends with high-melting paraffin wax have improved moisture resistance for, *e.g.*, food packaging. Clear emulsions of the resin should be useful sealers for alkaline composition board, plaster, brick, or cement surface. Incorporation into baking finishes reduces the baking temperature necessary to give good adhesion. C. L. G.

1018. War Products from Natural Gas and Natural Gasoline. P. M. Raigorodsky and F. H. Dotterweich. *Oil Gas J.*, 15.4.43, **41** (49), 94.—Major attention is given to the actual commercial processes by which light petroleum fractions may be converted into vital war products. It may be expected that increased discoveries of deep petroleum deposits will increase the percentage of light fractions in the total products available, thus ensuring adequate supplies to enable continued development of recent processes.

The most important war products derived from natural gas and natural gasoline sources are synthetic rubber, carbon black, aviation fuel, and explosives. War-time restrictions preclude a detailed review, but a general report on the more important commercial developments is given.

Butadiene.—In the production of butadiene by catalytic dehydrogenation of *n*-butane the commercial process of greatest importance is the Houdry. The differences between the one-stage process, to be used in a Sun Oil Co. plant having a capacity of 15,000 tons a year of butadiene, and the original two-stage process are enumerated. New critical material requirements of the one-stage plant are relatively small.

Thermal cracking of ethane–propane to yield ethylene which can be subsequently converted into ethyl alcohol provides another potential method of producing butadiene from natural-gas sources. The various methods available for converting ethyl alcohol into butadiene are briefly described, although it appears that at present alcohol manufactured from natural gas is not being used for butadiene production. Petroleum Chemicals, Inc., has designed and built a semi-commercial unit for cracking of hydrocarbons by regenerative heating and for the separation and purification of the olefins produced. The furnace is an adaptation of one designed for production of acetylene, and a flow-sheet and general description of the process are given. Heavy naphtha is used as charging stock, and a yield of 5·2% wt. of butadiene is reported. The possibility of producing ethylene, propylene, and benzene mixtures by this process is worthy of note when overall yields of desirable unsaturated hydrocarbons are of importance.

Carbon Black.—The advent of synthetic rubber has resulted in an increased demand for carbon blacks and a change in type most suitable for compounding for tyre manufacture as compared with natural rubber requirements. To meet this demand increasing quantities of furnace and thermatomic blacks are needed. Both processes are briefly described. In general, the efficiency of the furnace process increases with increased particle size and yields of from 3 lb. to 20 lb. per 1000 cu. ft. of natural gas are obtained as compared with 1 lb. to 5 lb. by the channel process.

Aviation Gasoline.—The importance of natural gasoline in augmenting aviation gasoline supplies is indicated and a scheme outlined whereby finished super-fuels could be produced entirely from natural gas sources by the utilization of stabilization, isomerization, dehydrogenation, polymerization, hydrogenation and alkylation processes.

Explosives.—Approximately half of the current production of synthetic ammonia is prepared with the aid of hydrogen obtained from natural gas by the steam conversion process. General outlines and a flow sheet of this process are given, and alternative methods for removal of CO_2 described. Synthetic ammonia is not only of importance in the production of explosives, but also used as fertilizer base, rubber accelerator, and in the preparation of nitroparaffins. Future exploitation of the nitroparaffins may produce explosives of such a nature that natural gas may develop into a still more

valuable source of explosives than at present. Benzene and toluene required for explosives manufacture, etc., may also be obtained from natural gas sources by thermal cracking or catalytic reforming. R. A. E.

1019.* Quenching Oils of Mineral Origin. E. R. Varley. *Petroleum*. August 1943, **6** (8), 120–122.—A short historical sketch of quenching is given and the theory is briefly discussed. Theoretically, water is the most efficient quenching medium, and actually oils, not only mineral, but also animal and vegetable oils, are only 15–45% as effective as cold water, and indeed even less so than certain aqueous solutions. Quenching with oils is frequently preferable where, for metallurgical reasons, a rate of cooling less rapid than that given by water is required. Another advantage of oils is that they tend to give more uniform characteristics throughout the cooling range, whereas the efficiency of water, though high at low temperatures, falls off considerably as the temperature rises. On the other hand, although oil is frequently used at or near atmospheric temperatures, it may with advantage be pre-warmed to something in the region of 35–60° C. It is probable that this is a result of the warmed oil enabling the vapour phase to be more readily achieved and the convection currents in the bath to be accelerated. Results of quenching in oil and in water are tabulated for comparative purposes. Further tables give the testing and properties of quenching oil.

As a result of such work on both sides of the Atlantic, it has been found that the mineral oils, as hydrocarbons, are vastly superior for quenching purposes to animal and vegetable oils, which are the glyceryl esters of higher-molecular fatty acids. This is well summarized in the report of the Alloy Steels Research Committee, which comes to the conclusion, after exhaustive tests on the line indicated on mineral, animal, vegetable, and compounded oils, that high-grade lubricating oils obtained by solvent extraction, and similar oils in which the more oxidizable portions of the oil have been removed, are the most suitable of all oils for the quenching of alloy steels. Hence, the nature and origin of an oil, as well as the method by which it is to be refined, will be prime considerations for the producer of quenching oils. Perhaps more important to the user, however, will be an empiric determination of how well a particular oil behaves in a particular job. It is of the highest practical importance to note that an oil suitable for quenching one specific alloy may be quite unsuited on metallurgical grounds for quenching another alloy, and even with the same alloy an oil suitable for treating small intricate articles made from it may be far from ideal for quenching a large solid object of the same material.

The paper is given in Spanish as well as English. A. H. N.

1020.* Effect of Petroleum Products on Buna S Vulcanizates. R. E. Morris, P. Mitton, J. C. Montermoso, and T. A. Werkenthin. *Industr. Engng Chem.*, 1943, **35** (6), 646.—The conventional tests for swelling and loss of tensile strength are misleading when applied to Buna S vulcanizates, since they give no indication of the loss in tear resistance which has been found to be appreciable in the case of these products. J. W. H.

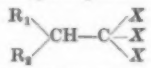
1021.* Effect of the Properties of Carbon Black on the Conductivity of Rubber-Tread Stocks. L. H. Cohan and J. F. Mackey. *Industr. Engng Chem.*, 1943, **35** (7), 806.—The conductivity of rubber-tread stock compounded with 50 parts of carbon black increases exponentially as the particle size of the black decreases. As the crystal structure of the carbon becomes graphitic the conductivity increases sharply, but this effect is of less importance than particle size. Removal of the surface constituents of the black by heating in a non-oxidizing atmosphere results in a product which, when incorporated in the rubber, increases the comparative conductivity tenfold.

J. W. H.

1022.* Solvent Properties of the C_8 Aromatic Hydrocarbons. P. D. Hammond and E. H. McArdle. *Industr. Engng Chem.*, 1943, **35** (7), 809.—Data for the surface tension and dielectric constant of pure samples of the C_8 aromatics are given, and measurements have been made of the solvent power with respect to Kauri-butanol, mixed aniline point, polybutene-*n*-decanol, and maleic resin values.

From these data it is shown that *o*-xylene is a most desirable solvent, since it combines the greatest solvent power with the lowest solution viscosity. J. W. H.

1023. Insecticidal Possibilities of Diphenyl Trichlorethane Derivatives. Anon. *Soap*, July 1943, **19** (7), 101.—British Patents Nos. 547,871 and 547,874 have been issued to J. R. Geigy, A.G., of Basle, for the use in the form of water emulsions, and powders, respectively, of insecticides containing compounds of the general type



where X is Cl or Br, R_1 an organic radicle containing at least 3 carbon atoms, and R_2 an organic radicle containing at least 5 carbon atoms. The toxicity is high, the odour in no way disagreeable, and there is no irritant action on the eyes, nose, or throat. Examples of the specific toxic compounds covered include :—

1. *pp'*-Dichlorodiphenyl trichlorethane—a solid of m.p. 103–105° C.—which can be dissolved in solvents and emulsified with sulphonated castor oil and ammonia, sulphonated fatty alcohols, etc., and used to control flies, moths, plant lice, beetles, etc. Insecticidal powders can also be obtained by mixing the above solution with talcum powder, porous materials such as charcoal, kieselguhr, bole, magnesia, chalk, etc., drying, and grinding. The products are suitable as moth-repellents or toxicants, or, in some forms, as general contact or stomach poisons. They are claimed to be able to replace rotenone completely. Solutions are used to control bed-bug infestation.

2. *pp'*-Dimethyldiphenyl trichlorethane, a solution of which can be emulsified with soft soap to give a stable insecticidal emulsion or used in the solid form.

3. *pp'*-dibromodiphenyl trichlorethane, a solution of which, heated with a cation active compound, gives an emulsion on dilution with water which is highly toxic to insects.

4. Diphenyl trichlorethane on bentonite milled with gelatine and potassium bichromate solution yield a paste from which a spraying mixture of excellent adhesive properties is obtained.

A mixture of 90% of pyrophyllite and 10% of *pp'*-dichlorodiphenyl trichlorethane is in use in the U.S. as a louse powder, the toxic product, a dyestuff intermediate, being in production. Details are given of the method of manufacture of the active compounds and of the insecticides. C. L. G.

1024. Water Emulsion of Pyrethrum. Anon. *Soap*, July 1943, **19** (7), 105.—It is reported from India (P. F. Russell, F. W. Knipe, and T. R. Rao, *Ind. Med. Gaz.*, **77**, 477) that kerosine as a carrier for pyrethrum can be successfully replaced at a third or a sixth of the cost by an aqueous emulsion. A dilution of 1 gal. of extract (from 2 lb. of pyrethrum flowers) with 3 or 7 gal. of water in the presence of Gardinol, sodium lauryl sulphate, or Perminal E.M.L. emulsifiers gives a satisfactory product, slightly greater amounts of the emulsion being required owing to the heavier droplets compared with those of the kerosine spray. C. L. G.

Coal and Shale.

1025. Use of Mixtures of Oil and Coal in Boiler Furnaces. W. C. Schroeder, *Mech. Engr*, November 1942, 793.—In a paper presented at the annual meeting of the Fuels Division of the American Society of Mechanical Engineers at St. Louis on 30th September, 1942, a review was given of information on the burning of ground coal suspended in oil with a view to encouraging its use at present under stationary boilers. For marine use its value lies in the more widespread availability of coal and the greater heat content (1–4%) per unit volume over that of oil fuel, but the ash disposal is dangerous in war-time, so that its use on land in boilers equipped for oil-firing is being considered.

Work was first carried out in the U.S. in 1917 by the Submarine Defence Association, using 0·5–5% of lime rosin soap to suspend 30–40 parts of coal in 60–70 parts of oil, but the product was insufficiently stable, steam purging of the jets being necessary at intervals. Attempts were later made to improve stability by increasing the viscosity of the oil by oxidation, emulsification, and prior removal of ash. The use of gels from metal soaps was also investigated. Attempts to use anthracite instead of bituminous coal failed owing to difficulty in grinding, high ash content, slow ignition, and poor wettability by oil.

In England experiments were made with resins, soaps, rubber, tars, and petroleum pitch as stabilizers and a plant built to produce the mixture, but the venture failed. Later full-scale tests were carried out in various Cunard liners, probably using lime rosin stabilizers with coal-cracked fuel oil, but while full data are not available, they were believed to be unsuccessful, possibly owing to the high-ash content, low-grade coal used. The Fuel Research Board made experiments with oils gelled with sodium stearate to improve the stability, while in the U.S. it was found that the use of tars instead of petroleum produced a gel-like structure of improved stability. In Japan the use of metallic soaps as stabilizers was found unsatisfactory, but a low-temperature tar from selected brown coal was a suitable peptizing agent. A tar-oil peptizer was also found satisfactory in Germany.

Various methods of grinding the coal have been tried, including the use of a colloid mill, grinding the coal and oil mixed, steam pulverization. In general, a particle size of 60–70 μ is required. In practice the presence of ash presents difficulties in furnaces designed for oil-firing, and operation at a lower rating only is possible. Further difficulties are the equipment necessary for grinding the coal at the plant or shipment of the pulverized coal, which is explosive, to the plant.

In general, it is felt that tests hitherto carried out have not been sufficiently systematic or extensive, nor have all the results obtained been rendered available. Some successful demonstrations have undoubtedly been made, and considerable activity is going on in this field. It is proposed that a survey should be made of oil-burning plants on the Eastern coast to consider where such mixtures could be used.

C. L. G.

1026.* Sweden Develops Large Output of Shale Oil and Makes Wide Use of Producer Gas. Anon. *Oil Wkly*, 12.7.43, **110** (6), 71.—More than three out of every five motor vehicles run on producer gas, and the country is exporting producer gas generators to several countries.

It is proposed to increase the shale oil production of the Vaestergoetland province from 37,000 metric tons to 81,000 metric tons. The plant at Kinne-Kleva now gives over 30,000 metric tons of fuel oil per year. The production of light benzine from gas formed in shale distillation is being developed. The Kinnekulle shale deposits may provide 25,000,000 tons of oil.

Ostergotland is estimated to have shale deposits capable of giving 250,000,000 tons of oil, and Narke province may yield 50,000,000–60,000,000 tons of oil.

In the Ljungstroem method of producing oil from shale, the shale is electrically heated underground. Shale oil is also produced by three other methods.

85% of Sweden's shale oil production is fuel oil, and some high-grade aviation gasoline is also obtained.

Sulphur is the chief by-product of the distillation process, and vanadium, molybdenum, and radium are obtained in small amounts.

Tar, used as motor fuel for the fishing fleet, is to be produced at the rate of 8,000 metric tons/year from 20 retort charcoal furnaces.

The experimental production of lubricating oils from crude destructively-distilled pine tar is being undertaken, and while suitable for simple lubrication, they are not satisfactory for internal combusion engines.

G. D. H.

ABSTRACTS.

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Geology and Development.

1027. Kansas : Rapid Development of Carmi Field Opens Important Area on South Flank of Arch. C. Hoot. *Oil Gas J.*, 29.7.43, **42** (12), 177.—The outstanding development of the northern Mid-Continent in the first half of 1943 was the rapid expansion of the Carmi pool. The field is nearly 3 ml. long, with 2000 acres proved. The average initial well potential is 2800 brl./day, from the Arbuckle at 4305–4329 ft.

217 wildcats were completed in Kansas during the first half of 1943, compared with 146 in the first half of 1942. 35 discoveries were made in the first half of this year. Most of the wildcats were on the Barton Arch, and the discoveries were generally within 3–5 ml. of proven areas, as during the past three years. The Studley pool of Sheridan County was, however, 12 ml. from the nearest field, and its discovery well gave 689 brl./day from the Lansing–Kansas City lime at 3808–3817 ft. The Deerhead field off the Barton Arch play came in with a well yielding 2785 brl./day from the Viola at 5005–5014 ft. The Hunter pool of Saline County produces from the Mississippian chat at a depth of 2674 ft. Major developments have merged the Zenith and Peace Creek pools, both of which produce from the Viola. The producing area runs north-east–south-west for 15 ml., and it gave 2,042,000 brl. in the first half of 1942 and 2,682,000 brl. during the same period of 1943.

Tables summarize the completions in the first half of 1943 by fields, and also summarize the wildcats, as well as giving the completions by months. G. D. H.

1028. Nebraska : Forest City Basin. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 178.—Production in the Forest City Basin has declined steadily during the first half of 1943, and the hoped-for Bartlesville sand development in Atchison County, Missouri, has faded from the picture. Seven dry holes were drilled in Missouri, and Nebraska had nine dry

holes and one oil-well from which 10 brl./hr. was swabbed from the Hunton lime at 2170–2180 ft.

The completions in Nebraska and Missouri during the first half of 1943 are summarized by months. G. D. H.

1029. Kentucky's Production Rises Following Wildcat Campaign. Anon. *Oil Gas J.* 29.7.43, **42** (12), 204.—A 100-brl. well at a depth of 2346–2369 ft. opened the Robards pool in Henderson County, while the Utley pool in the same County came in with a 200-brl. McClosky well at 2576–2581 ft. The Anthoston pool produces from the Aux Vases at 2184–2189 ft. In May the Morganfield field was opened by a 122-brl. well in the Mansfield sand at 1428–1445 ft. The Poole field produces from the Tar Springs at 1961–1976 ft., and the Cairo pool from the Waltersburg at 1890–1907 ft. In Daviess County the Panther pool was opened in the Bethel sand at 1833–1837 ft.

The completions are summarized by counties for the first half of 1943, and monthly completion totals are also given. G. D. H.

1030. Ohio : Penn Grade Field in Muskingum County. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 204.—A large Pennsylvanian-grade oil well has been completed in Falls Township, Muskingum County, and together with scattered wells in the eastern part of Newton Township and Madison Township, Perry County, and extending south to the Clayton pool, opens up a large potential producing area. Few Clinton sand wells were drilled outside of this area and the Clayton pool, and no important discoveries were made.

Gas is in demand in Ohio, and one of two wildcats in Ashland County found gas. Two pools were opened in Holmes County east of the present production, and there were successful tests in Jackson and Knox Counties. Gas was also found in Lorain, Medina, and Eastern Morgan Counties. Two Clinton and one shallow discovery were made in Perry County, and the Sandyville field, Stark County, and the Hinckley pool were extended. The Muskingum–Morgan gas-field has been extended to the north, east, and south.

The completions during the first half of 1943 are summarized by counties, and the monthly completion totals are also listed. G. D. H.

1031.* Good Well Is Completed in Turner Valley Field. Anon. *Oil Wkly*, 2.8.43, **110** (9), 47.—British Dominion Oil and Development Company's No. 5 new North Turner Valley well may receive an allowable of nearly 1000 brl./day. No. 6 is to be drilled ¼ ml. east of No. 5 and No. 7 ¼ ml. north of No. 5.

Deca 2, the first of a series of wells to be drilled in the Athabasca sands, is being tested. Taber-Providence 3 in the Taber field near Lethbridge is being tested. The Taber area has some good wells and dry wells. Taber, Vermilion, Ram River, and Athabasca are comparatively shallow areas. G. D. H.

1032.* Prolific Well Completed in Turner Valley North End. Anon. *Oil Wkly*, 2.8.43, **110** (9), 47.—British Dominion No. 3 at the north end of Turner Valley was reported to be flowing at the rate of 4800 brl./day on July 16th, and may become one of Turner Valley's largest wells. The lower porous limestone zone produced at 130–150 brl./hr., and the upper porous zone at 55–60 brl./hr. The structure is narrow at the site of the well. In May the Turner Valley production fell to a record low.

Shell's Jumping Pound test has reached a depth of 10,624 ft.

The Turner Valley Devonion test has settled down to produce at the rate of 200 brl./day, having been plugged back to the Madison after encountering a fault. G. D. H.

1033.* Crude Oil Production at New High For Year. Anon. *Oil Wkly*, 16.8.43, **110** (11), 102.—The U.S.A. oil production has risen to a new high for this year, and averaged 4,229,185 brl./day in the early part of August. This production is within 108,000 brl./day of the all-time peak reached in January 1942.

The daily outputs of the different states are given. G. D. H.

1034.* Commercial Gas Field in Athabasca Area. Anon. *Oil Wkly*, 16.8.43, **110** (11), 103.—Deca No. 2 in the Athabasca area has revealed a new gas-field in Alberta. The original flow is estimated at 15,000,000 cu. ft. of gas/day, but in a Government test the flow is reported to have been 22,000,000 cu. ft./day. Part of a core from 1654–1663 ft.

showed oil saturation, but this is cased off by casing set at the top of the Grand Rapids sandstone at 1674 ft.

A site for Deca No. 1 has been chosen 6 ml. east of No. 2, and a site for Deca No. 3 2½ ml. south-west of the discovery well.

The Deca gas-well is 80 ml. from Edmonton which draws its gas supply from the Kinsella and Viking fields 125 ml. away. G. D. H.

1035.* Will Complete Old Deep Test South of Calgary. Anon. *Oil Wkly*, 16.8.43, **110** (11), 103.—The fifteen-year old Ranchmen's well, 25 ml. south of Calgary, is to be completed. This well has been standing for a considerable period in the Dalhousie sand at 7240 ft. It struck many showings of oil and gas.

New Ranchmen's-Snider 1 well, now at 1700 ft., will also be completed. G. D. H.

1036.* Production Increasing in North-West Canada. Anon. *Oil Wkly*, 16.8.43, **110** (11), 103.—During the first five months of 1943 Canada produced 4,211,751 brl. of crude, as compared with 4,383,292 brl. in the same period of 1942. Alberta gave 4,074,469 brl. in the 1943 period, against 4,313,292 brl. in the 1942 period. The New Brunswick output this year was 11,335 brl., and 9165 brl. in the first five months of 1942, while the corresponding figures for Ontario were 53,420 brl. and 60,689 brl. respectively. The North-West Territories yielded 146 brl. of oil in the first five months of 1942, and 72,527 brl. in the corresponding period of 1943, the monthly figures being: January, 9107 brl.; February, 11,556 brl.; March, 17,374 brl.; April, 19,692 brl.; and May, 14,798 brl. G. D. H.

1037.* Crude Oil Production Up 9% in Peru. Anon. *Oil Wkly*, 16.8.43, **110** (11), 103.—For the first quarter of 1943 the Peruvian oil production was 3,627,127 brl., compared with 3,327,318 brl. in the same period of 1942. 275,644 brl. of natural gasoline were obtained, against 272,733 brl. in the first quarter of 1942. G. D. H.

1038.* Canadian Production Down in First Five Months of 1943. Anon. *Oil Wkly*, 16.8.43, **110** (11), 103.—In May the Canadian output of crude oil and natural gasoline was 872,812 brl., the April figure being 837,072 brl., and that for May 1942 892,034 brl. Alberta's output was 843,431 brl. of which 832,219 brl. came from Turner Valley.

During May the natural gas production was 3,115,270,000 cu. ft., compared with 3,659,984,000 cu. ft. in April, and 3,076,658,000 cu. ft. in May 1942. The total gas output for the first five months of 1943 was 21,760,864,000 cu. ft., against 21,083,130,000 cu. ft. in the same period of 1942. G. D. H.

1039.* Italian Oil Fields Small, but Important to Axis. Anon. *Oil Wkly*, 23.8.43, **110** (12), 10.—The Albanian crude production is believed to be about 3700 brl./day from some 550 wells in the Devoli field. The oil is about 16 gravity, and comes from depths of 2000–3000 ft. Italy's several small fields give a total daily output of roughly 125 brl., mainly from the region of the Po river.

Generally the Italian wells are small and shallow. In the early 1930's the daily output was around 600 brl./day, but later it declined. Six of the fields were south of the Po in the Apennines foothills, principally in the province of Emilia, south of Parma and west of Bologna. The oil is in fractures or sand lenses and sandstone blocks in the Argille Scagliose (variegated shales). This shale is highly fluid when wet, and has been observed to be intruded into joints, bedding planes, and broken anticlinal crests. The formation may be of Eocene age or transitional between the Cretaceous and Eocene. Heavy crude is produced from some twenty wells in a field midway between Rome and Naples.

Several areas in Albania, in addition to Devoli, are reported to show heavy crude.

At Ragusa, in Sicily, is the second largest asphalt deposit in the world, second only to the Pitch Lake of Trinidad. The asphalt impregnates a limestone. Sicily has numerous oil and gas seeps, nearly all associated with the Argille Scagliose. G. D. H.

1040.* July Discovery Record Best So Far This Year. L. J. Logan. *Oil Wkly*, 23.8.43, **110** (12), 20.—As in earlier months the July discoveries were predominantly of mediocre or poor quality, but the record number of discoveries made the total of crude discovered represent a substantial addition to the reserves. The outstanding discovery was the

development of Tensleep production in the Elk Basin field, Wyoming. This added about 135 million barrels of reserves, while all the other July discoveries may account for only 40–70 million barrels.

The present rate of production is about 120 million brl./month, and on the average the monthly discoveries have been falling below this figure in estimated reserves.

In July 296 exploratory wells were completed, about the same number as in June. During the first seven months of 1943 there were 1777 strict wildcat completions, compared with 1810 for the corresponding months of 1942. The percentage of successful wildcat wells has been lower than in 1942.

The Tensleep well at Elk Basin is on the south-west flank of the structure and well outside the Frontier producing area. Tensleep saturation was found at a depth of 5409 ft., 32 ft. below the top of the Tensleep. The initial production was 1440 brl./day of 31-gravity oil. The well may prove 6000 acres of Tensleep production.

The Atlanta field in Arkansas has been extended 1½ ml. by a well which produces from the Cotton Valley sand and the Smackover lime. Illinois has had three new small oil-fields, new pay horizons in four fields and eleven field extensions. Five oil- and one gas-field were found in Kentucky, while Kansas had five new oil-fields. North Texas had six new oil-fields, and new pays in three fields. On the Lower Texas Gulf Coast new pay horizons were proved in three fields, and a gas-field and two oil-fields were extended. The Stratton field with its prolific sands has been extended 2 ml. to the west.

Tables summarize by States and districts the results of wildcatting in July and during the first seven months of 1943. A list is given of the discovery wells completed in July 1943, with the name, company, location, completion and starting dates, depth, producing formation, initial production, oil gravity, structure and method of discovery, and a preliminary estimate of reserves where an estimate has been made. G. D. H.

1041.* Wildcat to be Drilled East of Turner Valley. Anon. *Oil Wkly*, 23.8.43, **110** (12), 42.—Drilling is expected to be resumed soon on the New Ranchmen's site, 18 ml. east of Turner Valley. At the site of the No. 1 well the Madison limestone is probably 8000 ft. deep. The Old Ranchmen's well in the same area was not completed because of operational difficulties. It went to 7200 ft. and had definite oil shows at six points in the last 1000 ft., without reaching the Madison, which is several hundred feet deeper. A seismic survey preceded the locating of the New Ranchmen's well.
G. D. H.

1042.* Canadian Oil Trickle Outside Turner Valley. Anon. *Oil Wkly*, 23.8.43, **110** (12), 44.—Turner Valley gave 95·3% of the crude oil and natural gasoline produced in Canada in May. An additional 1·3% was produced by other Alberta fields. The remaining 3·4% came from Ontario, New Brunswick, and Fort Norman. The total May output was 872,812 brl. In May 1942 Canada produced 892,034 brl. and in the first five months of 1942 4,383,292 brl., against 4,211,751 brl. for the same period this year. G. D. H.

1043.* Alberta's Crude Output Is Down This Year. Anon. *Oil Wkly*, 23.8.43, **110** (12), 44.—In the first six months of 1943 Alberta produced 4,643,264 brl. The output in the same period of 1942 was 4,988,473 brl. G. D. H.

1044.* Doing Geological Work West of Fort St. John. Anon. *Oil Wkly*, 23.8.43, **110** (12), 44.—Several geological parties are searching for oil in territory west of Fort St. John, British Columbia. The Hudson Hope area is believed to be favourable. Several years ago in the Pouce Coupe district, west of Dawson Creek, and south of Fort St. John, a large flow of oil was struck but not developed. Recent prospecting and drilling are believed to have located oil and gas. G. D. H.

1045.* Canada's Largest Producer Completed at Turner Valley. Anon. *Oil Wkly*, 23.8.43, **110** (12), 44.—British Dominion 5 well is reported to have produced at the rate of 4500 brl./day, making it probably Canada's largest producer. It is the most northerly producer in the proven area of Turner Valley. G. D. H.

1046.* Sharply Expanded Production Rates Feature of Recent Petroleum Trends. L. J. Logan. *Oil Wkly*, 30.8.43, **110** (13), 12.—In spite of curtailment of civilian oil consumption the over-all demand for petroleum continued to increase during August. P.A.W. production certifications for September call for 4,552,100 brl./day. The June figure was 4,218,900 brl./day. During the past three months the producing ability of Districts 1 and 2 has declined, and only nominal production increases have been possible in Districts 4 and 5. Hence the main increase has come from District 3, and especially from Texas.

Crude oil production in the first seven months of 1943 was 5·5% above the figure for the same period of 1942, and runs to stills were 3·4% higher. Last year the industry drew heavily on stocks of refined products, and so this year refinery runs have been closer to current demands than they were last year.

The main rises in production above the 1942 levels have been in California (20%), Kansas (19%), Texas (13%), New Mexico (21%), Louisiana (4·5%), Colorado (5%), Wyoming (4%), Kentucky (68%), Arkansas (1·6%) and Michigan (0·3%). Compared with the output in the first seven months of 1942 production in 1943 declined in Illinois (27%), Indiana (25%), Mississippi (37%), Oklahoma (14%), Ohio (9%), Nebraska (45%), New York (4·6%), Pennsylvania (10%), West Virginia (5%) and Montana (6%).

During the first seven months of 1943 790,350,000 brl. of crude was run to stills in U.S.A. In California the runs were 151,316,000 brl., against 122,191,000 brl. in the first seven months of 1942.

Recently the gasoline production has been increasing, and the kerosine production is 7% above that for the first seven months of 1942. The residual fuel oil production has risen by 15%.

Data on production, stocks, demand, and refinery runs are tabulated. G. D. H.

1047.* Non-Marine Wasatch Vast Rocky Mountain Potential Oil Source. J. B. Crapo. *Oil Wkly*, 30.8.43, **110** (13), 32.—The Wasatch formation of north-eastern Utah, north-western Colorado, and south-western Wyoming contains many extensive beds of tar-saturated sandstone. The largest and most extensive deposits are in the Uintah Basin and the Roam Cliffs in Utah and Colorado.

Over twenty-five years ago the White River structure, 20 ml. west of Meeker, Colorado, yielded gas, and in 1924 oil and gas were found at LaBarge, Lincoln County, Wyoming, in these beds. In the latter case the oil is 650–1000 ft. deep, in lenticular sands. The wells have had initial outputs of 5–300 brl./day, and to date the total production is about 8,000,000 brl. Gas was found at Hiawatha, Moffat County, Colorado, in 1925, and oil has been produced from some of the deeper sands. 25 ml. to the south-east the Powder Wash Dome has given oil and gas. In 1938 gas was discovered on the Big Piney Creek anticline, 16 ml. north of LaBarge, and later an oil-well was completed.

The above Wasatch discoveries seem to indicate that oil and gas in quantity are present and indigenous to these beds, and Nightingale states that there is no sign of faulting or fracturing on the Powder Wash Dome which would permit migration into the Hiawatha member of the Wasatch.

20,000 sq. ml. of Eocene beds await exploration in this region. G. D. H.

1048.* Several Alberta Wildcats Have Important Shows. Anon. *Oil Wkly*, 30.8.43, **110** (13), 49.—Sparky 1, south of Lloydminster, is reported to have struck oil, and Ram River 2 is being acidized after giving 33 brl./day. 20 ml. south-east of Wainwright Edgerton 1 is reported to have an oil and gas showing.

Several Turner Valley wells are nearing the producing level. G. D. H.

1049.* Crude Production Lower but Still Near Peak. Anon. *Oil Wkly*, 30.8.43, **110** (13), 49.—In the week ending 28th August, U.S.A. produced an average of 4,225,585 brl./day of crude, 7010 brl./day less than in the previous week. The decline was caused by the rises in production in California, Illinois, Indiana, Kentucky, Texas, West Virginia, and Wyoming failing to offset the falls in Kansas, Michigan, Oklahoma, Pennsylvania, Arkansas, Louisiana, and New Mexico. G. D. H.

1050.* Well Will Be Drilled Under Lake Erie's Bed. Anon. *Oil Wkly*, 30.8.43, **110** (13), 49.—A gas-well is to be drilled in Lake Erie, 1 ml. offshore from the southern end of the Tilbury gas-field. Gas is expected at depths of 1375–1425 ft.

Some years ago several gas-wells were drilled in the lake near Port Alma, but all were under ½ ml. from the high-water mark. It is believed that entry of water into the Tilbury field has "trapped" large amounts of gas beneath the lake. G. D. H.

1051.* Progress Being Made in Western Canada Drilling. Anon. *Oil Wkly*, 30.8.43, **110** (13), 49.—Fourteen wells out of fifty projected by one company have been completed or nearly completed in the Vermillion field. No. 6 pumped 100 brl. in 6 hours, and of the completed wells all except No. 5 have been successful. No. 5 seems to have missed the sand. Elmore 1, the most easterly well, is reported to be giving 70 brl./day.

30 ml. west of Calgary production has been resumed on the Moose Dome Devonian limestone structure. G. D. H.

1052.* Industry Dependent on West Texas for More Production. A. R. McTee. *Oil Wkly*, 6.9.43, **111** (1), 77.—For some time the Permian Basin has had a greater volume of shut-in production than any other part of Texas. It has also been viewed as one of the most favourable areas in which to find new sources of petroleum production, a belief which has been borne out by recent prolific Ordovician discoveries. Since the mid-twenties it has had a high crude reserve, as well as a considerable list of undrilled proven well sites. This condition has arisen largely from oil-outlet limitations. New pipe-lines are to be constructed, thus encouraging the development of proven and wildcat sites.

In September the Texas allowable has been pushed to 1,814,000 brl./day, with the largest increase (73,193 brl./day) assigned to the Permian Basin, making its total 327,642 brl./day. It has been suggested that West Texas could produce about 500,000 brl./day, and at present it is the only area in U.S. which is not producing at its maximum efficient rate. During 1942 the West Texas output fell from 311,300 brl./day in January to 212,600 brl./day in December. Since June 1943 the rate has risen by about 100,000 brl./day.

The capacity of some pipe-lines in West Texas has been increased, and new pipe-lines are to be built.

During 1943 new production has largely been confined to deep fields, and Ordovician discoveries have made West Texas a prominent contributor of new crude reserves in the first half of 1943. The deep tests are very expensive. G. D. H.

1053.* Argentine Oil Demand Only Partially Met: Production Seriously Off. Anon. *Oil Wkly*, 6.9.43, **111** (1), 121.—In 1941 Argentina consumed 33,000,000 brl. of oil and produced 22,500,000 brl. Its production in 1942 was at about the same level, but this year it fell by 23% in the first quarter. It is expected that only about half of Argentina's normal demands will be met this year, due to virtual cessation of imports and the decline in production through shortage of drilling and other equipment.

In 1942 Y.P.F. drilled 72 exploitation wells with a total footage of 335,747 ft. Forty-six old wells were deepened. 15,407,154 brl. of oil were produced, 1,378,364 brl. more than in 1941.

Lack of adequate coal and oil supplies is impeding Argentine industry and transport. The lack of fuel oil is especially marked. The Government has recently agreed to supply 2,250,000 brl. of oil to Uruguay, Paraguay, and southern Brazil in return for drilling machinery from U.S.A. G. D. H.

1054.* Alberta Drilling Active Outside Turner Valley. Anon. *Oil Wkly*, 6.9.43, **111** (1), 124.—Fourteen wells are now being drilled in Turner Valley, and 11 elsewhere in Alberta. The current Alberta production is 25,612 brl./day compared with 27,584 brl./day a year ago. At present Turner Valley gives 23,917 brl./day of crude and 1,186 brl./day of natural gasoline, while 509 brl./day of crude are obtained elsewhere in Alberta. A year ago the Alberta crude production outside Turner Valley was 400 brl./day. G. D. H.

1055.* Production Increasing in Vermillion Field. Anon. *Oil Wkly*, 6.9.43, **111** (1), 124.—During June the Vermillion field produced 6092 brl. of oil without any new wells. The completion of new wells in July and August may be expected to have increased the output in those two months. G. D. H.

1056.* Well Drilling Ahead in Athabasca District. Anon. *Oil Wkly*, 6.9.43, **111** (1), 124.—Deca No. 1 has reached a depth of 350 ft. It lies 6 ml. east of Deca No. 2, which is reported to have flowed 22,000,000 cu. ft. of gas/day. G. D. H.

Geophysics.

1057.* Electrical Logging Through Thick Salt Zones. J. A. Kornfeld. *Petrol Engr*, August 1943, **14** (12), 96.—Continuous circulation of drilling mud through shallower saline beds minimizes and sometimes destroys the spontaneous potential phenomenon when an electrical logging survey is run. This causes difficulties in interpretation, and so has discouraged the use of electrical logging in certain parts of western Kansas.

In practice this difficulty has been overcome by pumping fresh-water mud through the drill-stem from the bottom of the hole, and by using a greater recording range on the recording graph. The fresh-water mud is made up to a higher density than the salt-laden mud fluid in order to prevent mixing.

The troublesome salt beds of Kansas are in the Permian Nippewalla group, Ninnescah shale, and Wellington formation. The most important salt beds are in the Wellington formation, and cover an area 180 ml. from north to south, and 150 ml. from east to west with a maximum thickness of 300 ft.

Two principal effects are involved in the spontaneous polarization phenomenon: (*a*) electro-filtration and (*b*) electro-chemical contact effect. The electro-filtration effect arises from the mud filtering from the hole into the formation through the mud cake. The potential so developed is always negative and directly proportional to the mud resistively. It is proportional to the formation permeability. The electro-chemical contact affect depends on the salinities of the mud and formation fluids. It may be positive or negative, and is proportional to the logarithm (Napierian) of the ratio of the chloride concentrations in the two fluids in contact. If the salinity of the drilling mud is greater than the salinity of the formation fluid, the contact potential is positive. In some cases this positive potential may more than offset the negative potential due to electro-filtration, and so yield a positive anomaly.

A case in which the new technique was applied is described in some detail.

G. D. H.

1058.* Two-Year Summary of Geodynamic Prospecting Results. S. J. Pirson. *Oil Wkly*, 2.8.43, **110** (9), 23.—During the past two years 2500 stations have been made in over 70 independent geodynamic surveys in 14 different states of U.S.A. and Canada.

Geodynamic prospecting purports to measure the undisturbed rate of hydrocarbon gas diffusion through a measured area of the earth's surface. The permeability of shales and other dense rocks is of the order of 10^{-8} to 10^{-12} Darcy. It is assumed that the ethane and heavier hydrocarbons are not alteration products of organic matter in the soil or sub-soil.

Since methane is the main constituent of marsh gas leakage measurements cannot be based on this gas. Having regard to the nature of the assumptions and the lack of proof or disproof of their validity, the value of the method must be assessed statistically.

Two and often three measurements are made at each station in shallow boreholes 10–20 ft. apart. The precision of a measurement is of the order of 2×10^{-4} c.c. of ethane per day. The rate of flow through an area of half a square foot ranges 5–100 or even 200×10^{-4} c.c./day of ethane. The background values are about $6–8 \times 10^{-4}$ c.c. per day, and only values of 10×10^{-4} c.c./day or more are of interest. So far no well has proved productive in an area within a region of negligible leakage.

The results of wells drilled where geodynamic predictions had been made are tabulated, and some of the contour diagrams of the diffusion rates are presented.

G. D. H.

Drilling.

1059.* How to Inspect Drums Used With Wire Rope. A. J. Morgan. *Oil Wkly*. 21.6.43, **110** (3), 31–32.—Three checks are to be made on drums: (1) *Contour*. With plain-faced drums corrugations on the face will cause the same damage to the rope as discussed under sheave materials. Drums which have become corrugated should be

re-machined. Where the drum shell is too thin it may be lagged with steel plate. (2) *Symmetry*. If the drum face is low at one spot the rope will tend to pile up at this point. The rope coming onto this part of the drum first will wind in too open a wrap, whereas that on the other side of the low spot will wind too tightly, thus causing undue rubbing of adjacent wraps. (3) *Winding*. Where grooved drums properly designed for the rope to be used upon them are employed, no winding difficulties are usually encountered when the fleet angles are satisfactory. Where plain-faced drums are used, however, care must be taken to see that the wire rope winds onto the drum evenly in a continuous loosely closed helix so that one wrap just touched the adjacent wraps. Too-tight winding of rope will cause one wrap to scrub unduly against adjacent wraps, and thereby cause excessive abuse. With multiple-layer drums too-open winding will allow the upper layers to pull down between wraps of the bottom layers, thus causing scrubbing, pinching, and other excessive abuse of the rope.

Fleet angle is discussed. This may not exceed 1·5° and not less than 0·5°. Operating conditions are very briefly discussed. A. H. N.

1060.* An Instrument for Inspecting Interior Pipe-Wall Conditions. F. Briggs. *Oil Wkly*, 12.7.43, **110** (6), 28.—An adaptation of the telescope that was originally designed for inspection of gun barrels now makes it possible to examine the inside walls of tubular goods for defects. Thus, for example; it is now possible to determine how each joint of drill-pipe is wearing, thereby continuing much of it for additional service that for reasons of safety might have been discarded previously. Or, some of the drill-pipe that previously might have been left in service is now junked because of defects revealed by the tubular telescope.

The simple construction of a telescope involves primarily two lenses: the objective or end lens that concentrates the light-beam and the eye-piece lens which magnifies the image. The instrument for inspecting pipe interiors, familiarly known as the tuboscope, contains both these lenses, plus intervening lenses that tend to maintain the intensity of the light-beam for the length of travel in the telescope tube. These are known as condensing lenses. Sections of tube containing three intermediate lenses each can be added to make the tuboscope any desirable length (up to 25 ft.). Just in front of the objective lens is a mercury-vapour lamp attached to the instrument; this provides light for a longitudinal view of the pipe walls of about 10 ins. Examination of the entire length of a joint of pipe is accomplished by inserting the lighted end of the instrument into one end for the length of the telescope, and then repeating the same at the other end of the pipe. Spring centralizers spaced at adequate intervals keep the instrument centred in the pipe. Right-angle vision of pits and other pipe-wall defects can be obtained by means of a highly polished mirror of stainless steel attached to the instrument between the viewing light and the objective lens, and set at an angle of 45° to horizontal.

Preceding all examinations, the pipe-walls are cleaned thoroughly with rotary wire brushes driven by air pressure. This air also blows the loose particles from the pipe. After cleaning, the instrument is pushed slowly through the pipe as an inspector examines the inner walls. If a pit or scar or lap-weld is found, the operator turns the instrument over until he gets the desired object located in the angle mirror. This permits a vertical view of the affected part, thus giving the operator a closer, more accurate picture. Should measurements be desired, a small pit-depth gauge can be attached to the instrument. A. H. N.

Production.

1061.* West Texas Experimental Water Flood Successful. R. W. Byram. *Oil Wkly*, 21.6.43, **110** (3), 15–17.—Experimental water-injection operations by Humble Oil & Refining Co. on its Louis Richter lease in the Estes field, Ward County, West Texas, have been sufficiently successful to warrant expansion of the programme. This conclusion has been reached as a result of tests made during the past year, and is of interest, since it is the first water-flood project of the Permian Basin. Although only two injection wells have been used, and each of these has put water into different zones, production of the lease has been increased. Furthermore, tests indicate improvement of bottom-hole pressures in the majority of surrounding wells. The geology and history of the field's development are given.

The project actually got under way about October 1, 1942, and some favourable results were apparent in recent months. Tests of wells surrounding the injection wells were made in January 1943, and another series of tests was made on 5th April, 1943, or 76 days later. Results of these surveys are indicated. Significantly, fourteen of the eighteen wells tested showed material pressure increases. Pressure losses were indicated in four wells, but two of these were shut in for several days before the first test and for only 48 hrs. prior to the later test. The remaining two were east-edge wells with offset producers, some distance from the injection wells, indicating a normal pressure decline. The average increase in pressure for the 76 days was 70 lbs. or almost 1 lb./day, excluding the two wells which had variation in shut-in time. The results are excellent when it is noted that these are stripper wells producing from a gas-driven reservoir.

While the evidence is not conclusive, it seems probable that if the programme were extended to other leases in the field, productive capacity of the poorer wells would be raised, and the ultimate recovery of the field increased materially. Such a programme would require a regular pattern of injection wells if the most efficient results are to be obtained. Expense of the experimental operation indicates that costs would be reasonable. A total of 123,122 brls. of water had been injected by 1st April, 1943, at a total cost of $1,631.54, or 1.3 cents/brl. This included the cost of electricity generated by the lease plant; without this charge the cost could be reduced to 1 cent/brl.

A. H. N.

1062.* Significance of Secondary Recovery In the United States. P. D. Torrey. *Oil Wkly*, 21.6.43, **110** (3), 18. *Paper Presented before American Association of Petroleum Geologists.*—This paper forms the first section of a symposium on secondary recovery which is to include four papers. Secondary recovery is defined, in accordance with A.P.I. definition, as the oil, gas, or oil and gas recovered by any method (artificial flowing or pumping) that may be employed to produce them through the joint use of two or more well-bores. Secondary recovery is generally recognized as being that recovery which may be obtained by the injection of liquids or gases into the reservoir for the purpose of augmenting reservoir energy; usually, but not necessarily, this is done after the primary-recovery phase has passed.

From this definition it will be appreciated that there are four fundamental requirements for the application of secondary recovery methods: (1) An injection well and (2) a producing well or wells all drilled into (3) a common porous oil-, gas-, or oil-and-gas-bearing formation through which (4) liquids or gases are forced under artificial pressure for the purpose of increasing oil recovery. The importance of secondary recovery is discussed in some detail.

The influences of geological factors are studied. The accumulation of oil in many of the fields in which secondary recovery methods have been employed in the past has been controlled by lenticularity of the reservoir rock—*i.e.*, they are stratigraphic-trap type fields. As such, many of them have not received the benefits of active, natural water encroachment, and the oil has been produced by internal gas-drive, generally regarded as being the least efficient natural reservoir performance. In addition, it should be kept in mind that most of the existing secondary-recovery operations are located in the older fields, which were produced initially at times when little attention was given to the conservation of reservoir energy. In consequence, the solution gas was extravagantly wasted, and when this propulsive agent was dissipated, subsequent production could come only from gravitational drainage. The oil left in the reservoirs by these early, inefficient primary-recovery operations is the oil which is now available for the application of secondary-methods.

Some clue as to the adaptability of a field to secondary-recovery methods can be gained from an analysis of past reservoir performance. If natural water encroachment has been active and uniform, the residual oil content, after the primary period of production has passed, will probably be too low to permit profitable secondary-recovery operations. The effectiveness of natural water encroachment should not be taken for granted unless production records are available to confirm a high degree of recovery efficiency. Frequent instances are known where water has migrated rapidly through relatively thin zones of high permeability, and has drowned out the wells by the formation of water zones, leaving most oil unrecovered in the less permeable strata. A field in which such conditions exist can be regarded as a favourable prospect for the

application of secondary-recovery methods, provided the offending strata of high permeability can be plugged off successfully.

The problem met in fields of divers ownership are briefly indicated. The paper then deals with prospective areas of the U.S. adaptable for future secondary recovery.

A. H. N.

1063.* Flowing Water-Flood Production. T. F. Lawry. *Oil Wkly*, 12.7.43, **110** (6), 46. *Paper Presented before American Association of Petroleum Geologists.*—This is the fourth part of a symposium on secondary-recovery. There are two departures necessary from conventional water-flood operations before flowing may be said to be successful. These are: (1) Delayed drilling of oil-wells, and (2) cementing of packers in both oil- and water-intake wells. Delayed drilling has been a controversial production method, at times highly favoured, and at other times being little regarded. It involves the drilling of water-intake wells first with simultaneous water injection into the sand being flooded. When the intake wells have filled the sand until it may be said to be 10% fluid saturated, the intake rate on the water wells will suddenly fall, giving the operator a signal that the sand has approached complete fluid saturation and is ready for the drilling of producing wells. One objection to delayed drilling is that the oil-wells come in almost wild and may waste substantial quantities of crude. However, this is almost unavoidable, because sand conditions are not uniform enough to permit an even flood-front to be maintained throughout the sand from the time the first water is injected until the oil-well is ready to flow. Consequently, if oil- and water-wells are drilled simultaneously, a back flood of oil or water from the more permeable streaks upon the less permeable streaks will result in the oil-well and delay the entire flood. The reason for the second departure is evident, but is briefly discussed.

The advantages of flowing over pumping are many, but the chief point is economy. Since flowing utilizes some of the energy imparted to the intake water, the mechanical elements for a flowed flood are very simple—just the water-pressure plant. No powers or individual pumping units are required; there are no jacks and surface rods to be kept greased and aligned, nor is there a string of sucker-rods and working barrels with their valves coming unscrewed, broken, and requiring frequent repair. Aside from the mechanical simplicity of flowing, the lesser cost of materials and the fact that much material is not tied up on one job for a protracted period provide further advantages.

Still another real advantage that flowing has over pumping is the reduction in time and number of men required for installation and maintenance of equipment. It usually requires an experienced crew to build powers and run rod-lines and set jacks. In addition, still another gang is always needed to pull the rods and tubing on pumping-wells. Also, the pumper has to act as nursemaid to a balking engine and oiler to a thousand places that the switcher on a flow job never gives a thought about.

The chief argument against flowing is the back pressure imposed on the sand. Operators who thoroughly appreciate the merits of flowing acknowledge the fact that back pressure on the pay does exist, but, on the other hand, instances are cited where old natural floods, operating at less than hydrostatic head for the depth of the sand, and with low intake rates, permitting prolonged back pressure on the sand, have reduced residual saturation below that possible with the forced water-drive. Some credence is now being given to the idea that limited withdrawal can recover more oil than a normal flood, for the reason that it usually operates at lower intake rates. Certainly the criterion of a successful flowing flood is not that it operates at greater pressure than any other. Another objection to flowing is the necessity for cementing the tubing in the hole. This can be refuted when full realization is given to the fact that nothing mechanical can possibly go wrong down in the hole. If cement-lined tubing is used, there should be no trouble from internal corrosion. If the hole below the packer should cave, an insert string of $\frac{1}{2}$ or $\frac{3}{4}$-in. pipe can be used to wash the hole, or if mechanical failure of the pipe would necessitate replacement, a companion string of left-hand thread-pipe can be used to fish the faulty pipe out down to the defect, after which the original may be replaced and made whole.

A. H. N.

1064. Fitting Pumping Practices to Individual Wells Yields Best Results. H. F. Simons, *Oil Gas J.*, 15.7.43, **42** (10), 41.—Oil-wells encounter widely different conditions in the pay, and variations in completion methods often cause their response to pumping to

vary from the expected behaviour. A few examples are given which show the losses which may result from absolute conformity to general practice in all cases. Under a number of formational conditions, it may be well to discard, or at least modify, the rule about never exposing the sand-face. As an example, a well with a pay formation containing productive strata alternating with non-productive porous strata or water-productive zones separated by impervious streaks might lose considerable production by not exposing the sand-face. If the non-productive porous zones contain no pressure, the oil can flow into the well-bore and then flow out again. If there is water in one or more of the zones intermingled with the oil-pay strata, the water flows into the well-bore, and, if it carries a slightly greater pressure, movement of oil into the well-bore is retarded. Or, the rate of flow of the water-bearing zone may be slightly higher than the oil-producing zone, and consequently the well fills up with a fluid which is mostly water.

One permian basin superintendent was able to boost his production from a lease from around 7 brls. to 18 brls./well, by recognition of this condition. Gas-lift was being used to produce the wells, and he lowered the standing valve and accumulation chamber to as near bottom as possible. He also decreased the time between injections of lifting gas controlled by the intermitter. By the time ½ brl. of fluid accumulated in the well-bore, opening of the gas-lift valve lifted it to the surface. In this case it was possible to disregard the lifting gas–oil ratio, as the gas supply was obtained from a well on the lease, and after returning to the surface along with the oil it was separated and sold. In other words, there was no charge for the gas, as it was merely used while en route to market.

There are corrective techniques available for shutting off water, thief-zones, caving sections, and sand coming into the well with the production. However, where the well's production is small, the investment required to effect a positive correction is often out of proportion. Another difficulty is the establishment of the true and exact conditions. When one is attempting to shut off either a thief or water-bearing zone, the exact location of the zone must be known. If the zone is only a foot in thickness, several attempts may be required to seal it off with affecting the oil-productive capacity of the well. Because the economic margin is small, the operator is limited in what he can do in the way of actual repair work, whereas alleviation or control steps are within his means. A. H. N.

1065. Sucker-Rod Pumping System. J. Zaba. *Oil Gas J.*, 15.7.43, **42** (10), 67.—Pumping systems are classified. Sucker-rod pumping is similarly classified, and the pumping motion is analyzed for an ideal pumping cycle. With pump immersed in fluid, which is a necessary prerequisite for its operation, the upward motion of the plunger on the beginning of the upstroke results in closing the travelling valve, because of the weight of the fluid above the plunger in the tubing. At the same time, because of the upward movement of the plunger, a decrease in pressure is created under the plunger in the working barrel, which results in the outside fluid opening the standing valve and entering and filling the space in the working barrel under the plunger. When the motion of the plunger is reversed after the top of the stroke has been reached, the weight of the column of fluid is placed on the standing valve, closing it. At the same time, opening the travelling valve permits the plunger to travel downward, through the fluid, to the point of beginning of the cycle. One of the most important characteristics of this cycle is the transfer of load of fluid in the tubing from tubing to sucker-rods on the upstroke and from sucker-rods to tubing on the downstroke. Deviations from the ideal stroke are discussed.

Loads are next analysed, particular attention being paid to vibrations. In case of sucker-rod strings two sets of vibrations are present: (1) those resulting from the pumping motion of the sucker-rods; (2) the natural vibration of the sucker-rod string. It is apparent that from the standpoint of the loads involved non-synchronous conditions for these two sets of vibrations are desirable. With velocity of stress transmission in sucker-rods as 15,800 ft./second in mind, Slonneger derives the formula for the frequency of vibration of sucker rods

$$F = 237{,}000/D$$

where F = frequency in cycles/minute, D = length of rods in feet. For instance, for a sucker-rod string 4000 ft. long the frequency of vibration of the rods would be

237,000/4000 = 59·25 cycles/minute. If the frequency of the pumping motion is the same—that is, 59·25 cycles/minute (strokes/minute) conditions of synchronous vibration would exist.

If the impulses are added at intervals which are equal to the natural frequency, then the vibrations are defined as "first-order vibrations." They are most severe, since each wave is augmented by new energy. "Second-order vibrations" are those in which impulses are added with frequency equal to half the natural frequency, etc. In the above example the speeds of 29·62, 19·75, etc., strokes/minute would be synchronous for a 4000-ft. string of sucker-rods and the vibrations would be of second, third, etc., order. Above and below those speeds the vibrations are non-synchronous. A chart, based on Slonneger's formulae, gives the synchronous and non-synchronous speeds with well depths. A. H. N.

1066. Calculation of Well-Repair Expense. E. H. Short, Jr. *Oil Gas J.*, 22.7.43, **42** (11), 25.—The author compares well-repair expenses calculated in terms of cost/barrel with cost/polished-rod horse-power hour of operation. While pump expense has been used as an example, the polished-rod horse-power hour unit of cost appears to offer also a more accurate method of evaluating well-repair expense than cost/barrel, when applied to the operation of tubing, sucker rods, pumping unit, and engine. In the case of engine operation the loss through the transmission equipment must be added to the polished-rod horse-power.

In subsurface-equipment operation the accuracy of the polished-rod horse-power method is dependent on the application, and a comparison can be only approximate unless the characteristics of the well are the same. Obviously there is a need for an equation which considers both polished-rod horse-power and corrosion. However, at the present time the technique in determining the relative corrosiveness of well-fluid is unsatisfactory and the usual sulphide classifications are shown simply as light, medium, and heavy. Where comparisons in pump expense are to be made on a polished-rod horse-power hour basis, until sufficient data are assembled to arrive at an empirical figure or factor to be used in the polished-rod horse-power equation which will give due consideration to the additional pump wear encountered in wells pumping from a sand horizon, such comparisons must be confined to wells in the same producing classification, *i.e.*, sand or lime. A. H. N.

1067. Sucker-Rod Load Measurement. J. Zaba. *Oil Gas J.*, 22.7.43, **42** (11), 34.—The three types of dynamometers, hydraulic, mechanical, and electrical types, are briefly described. The ideal card is then discussed, and distortion of the card by friction, deadweight, and vibrations is studied. Finally, the dynagraph is described. The pump dynagraph determines the load on the plunger by recording the stretch of a calibrated rod installed in the sucker-rod string above the pump and coupled to the pull-rod of the pump. The record is made on a thin recording tube, enclosing the calibrated rod and fastened to one of its ends through a nut threaded on to the rod. The record is made by a stylus attached to a rotating tube. This tube encloses a portion of the recording tube, and is set in a bearing on the other end of the calibrated rod. Thus any stretch of the rod causes the stylus to make a vertical line on the recording tube. At the same time the rotating tube, with the stylus, is made to rotate around the recording tube in a horizontal motion, proportional to the vertical reciprocating motion of the plunger. This rotating motion is caused by two spiral grooves in the rotating tube and two lugs, mounted at the upper end of the third tube, the cover tube. The cover tube, being attached to the pump body, is stationary. With reciprocating motion of the sucker-rods, the lugs of the cover tube ride in the spiral grooves of the rotating tube, causing this tube to rotate in a horizontal oscillating motion. For one complete motion of the plunger, therefore, the stylus makes a horizontal line on the recording tube. The resultant of the vertical motion of the stylus (due to calibrated-rod stretch) and of the horizontal motion (due to rotation of the stylus) is the pump dynagraph card. The card shows loads on plunger in relation to its position. By turning the rods at the well-head, the recording tube may be moved up on the calibrated rod, making possible recording of several cards without pulling the instrument out of the hole. The rotating tube, after being taken out of the instrument, on completion of the test, is flattened into a sheet for inspection and reading of the card. A. H. N.

1068.* Shallow Wells Cleaned With Air and Water through Tubing. F. B. Taylor. *Oil Wkly*, 2.8.43, **110** (9), 13–14.—Regular equipment for this means of cleaning out includes a two-stage air compressor, preferably driven by a gasoline engine. While the 600–700 lb. usually available with a two-stage compressor is not used in a routine clean-out operation, it is desirable to have this pressure at hand in case of need. A chamber suitable for compressed air storage, either mounted upon the same frame or mounted as a unit, is required. One operator has used a short length (about 16 ft.) of 12-in. casing, orange-peeled at both ends, and with 1½-in. connections set into the welds. This, including 1½-in. pipe swings to afford flexibility in locating the units with respect to each other, is mounted on a light frame and wheels so that it may be trailed to any location.

A string of ½-in. equivalent to the depth of the well is also needed, as is an adapter between the 1½-in. and the ½-in. This is easily made from a 1½-in. collar, welded in an orange peel and cut through the centre for the insertion of a short, ½-in. nipple. A tee on the 1½-in. above the well-head serves as an outlet for the cleanings from the well. In operation, air pressure at 100–150 lb. is fed into the well through the macaroni string after it has been lowered to a position opposite the face of the pay. There should be some water in the hole, and this is usually available from the formation, of, if necessary, by injection from the surface. Agitation produced by the air pressure escaping through perforation near the bottom of the ½-in. blasts the water against the face of the formation and into any accumulations of cavings. The air escaping up the annular space between the ½-in. and the 1½-in. carries the dirt to the surface. It is usually desirable to keep the bottom of the ½-in. closed, particularly if most of the force is to be directed against the side of the hole. A. H. N.

1069. The Permeability of Porous Solids to Gases and Liquids. L. Grunberg and A. H. Nissan. *J. Inst. Petrol*, August 1943, **29** (236), 193–225.—Permeability to gases is dependent mainly on Reynolds' number, which at small values gives rise to maxima and minima. For higher values of Reynolds' number, but preceding the turbulent regime, permeability assumes a constant value corresponding to viscous conditions. Thus for low rates of gaseous flow in rocks, tests should be carried out at Reynolds' numbers corresponding to those obtaining underground. The "Reynolds' number" may be taken simply as the volumetric rate of flow/unit area of sand, the area being perpendicular to the main line of flow. In other words, the mean linear speed of the gas is taken as the "Reynolds' number." It is further recommended that tests be carried out under a mean pressure equal to that existing underground.

Permeability to liquids is dependent not only on the viscosity, but also on other properties of the liquid which cause a variation in the effective cross-section of the pores under viscous flow. The coefficient of permeability assumes different values for different liquids having different surface-tension values. A single curve was obtained for the different liquids used by plotting against the criterion $\left(\frac{\mu^2}{\rho\sigma}\right)$. The permeability also varies with the temperature for the same liquid, but a correction for this can be obtained for each liquid: $K = a - b^{\circ}t\,C$. A. H. N.

1070.* Design of Tapered Sucker-Rod Strings. E. N. Kemler. *Oil Wkly*, 2.8.43, **110** (9), 31–32.—Formulæ are derived and used to calculate the proportion of each size of sucker-rods to be used in mixed strings. The formulae are derived from consideration of acceleration loads. The determination of proper proportions in sucker-rod strings is partly a case of analysis and partly a case of checking performance in the field. Unfortunately, it is not easy to determine proper proportions of sucker-rod strings in all cases from field records, the reason being that a failure in the upper part of the string results in dropping of the entire string. This might cause over-stressing of the upper end of the smaller rods. Such over-stressing might then result in a large number of failures in the smaller rods. An interpretation of the failure record would, under these conditions, indicate that there is an insufficient number of larger rods.

The results of the analysis are tabulated. The proportions are independent of the well-load. A. H. N.

Gas.

1071. Diethylene Glycol Absorbent for Hydrate Removal. Anon. *Refiner*, May 1943, **22** (5), 139.—Removal of entrained moisture and water vapour from natural gas is being successfully and inexpensively accomplished by a large utility company in a small specially designed semi-automatic plant employing diethylene glycol as an absorbent. The gas is produced from a formation carrying large quantities of water around the edges of the field and in the lower sections of the zone, which causes all of the fuel to be wet in the sense that excessive water vapour is suspended or absorbed. Pipe-line drips between the dehydrating station and the wells in the field accumulate the remove condensate and free water, but are, in themselves, not adequate to condition the gas fully for pipe-line transmission.

To prepare the pipe-line to receive the dehydration plant, a section was removed and replaced with a master gate and a by-pass manifold which includes the absorption-column piping. The column acting as the absorber has sufficient baffles and bubble plates to insure adequate contact between the gas and the absorbent. The flow of gas is conventional, entering the base of the column and passing out at the top, both inlet and outlet being served by short lines to prevent excessive use of pipe and fittings. A direct-connected outside-mounted float cage and control valve maintain a level of the absorbent in the column, perhaps one-third the distance from the base to the top, so that a turbulent contact can be obtained between the gas and the diethylene glycol. The glycol is regenerated, freed from water, and recirculated. A. H. N.

1072. Normal Butane. R. C. Alden. *Refiner*, May 1943, **22** (5), 145–147. *Paper Presented before Natural Gasoline Association of America.*—The use of normal butane as a raw material for producing aviation fuels and aviation fuel-blending agents is discussed. A. H. N.

1073. Nomograph for P-V-T Relations of Gases below the Critical Point. G. W. Thomson. *Industr. Engng Chem.*, 1943, **35** (8), 895.—A nomograph is presented which enables the compressibility factor and fugacity of a gas to be calculated from the reduced pressure and temperature. J. W. H.

1074. Volumetric Behaviour of Methane. R. H. Olds, H. H. Reamer, B. H. Sage and W. N. Lacey. *Industr. Engng Chem.*, 1943, **35** (8), 922.—Data are presented for the volumetric behaviour of methane over the temperature range 100–400° F. and at pressures up to 10,000 p.s.i. The results show complete agreement with previously published data up to pressures of 4500 p.s.i. Above this pressure the deviation only amounts to 0·25%. Since the sources of the methane and experimental procedure varied in the several investigations, it is concluded that the behaviour of this gas has now been established. J. W. H.

Refining and Refinery Plant.

1075. Use of Interrupting Devices in the Clearing of Electrical Circuits. W. A. Holland. *Refiner*, July 1943, **22** (7), 211–212.—Because there is always the possibility of a fault, a short circuit, in any electrical circuit, interrupting devices are necessary to clear such faults which might otherwise damage equipment. The interrupting device must have adequate "IC" (interrupting capacity) to clear the circuits safely and quickly, and must also have sufficient momentary capacity to withstand the effect of the maximum short-circuit current the circuit can develop.

It is necessary to know how to calculate the short-circuit current, and the paper described a simple method for doing it. Ratings and reactances of the machines involved must be known (data on generators, transformers, and motors can be obtained from their manufacturer); and also the reactances of circuits (calculated from rules not given in the paper). A. H. N.

1076.* Countercurrent Multitubular Heat Exchangers. M. G. Larian. *Industr. Engng Chem.*, 1943, **35** (8), 840.—The theoretically correct equation for the calculation of heat transfer in exchangers of this type is compared with various methods which have

been proposed, from the point of view of simplicity and accuracy. It is shown that for the prediction of film coefficients the Sieder–Tate graphical correlation should be used for Reynolds' Numbers less than 8000, and that at values above 8000 with this method or the Dittus–Boelter correlation there are serious discrepancies. J. W. H.

1077.* Power Consumption of Propeller-Type Agitators. C. E. Stoops and C. L. Lovell. *Industr. Engng Chem.*, 1943, **35** (8), 845.—A discussion is presented covering the theoretical factors governing the power requirements of agitator systems. By means of an agitator fitted with a torque-type dynamometer, a description of which is given, the effect of the variables, propellor diameter, shaft speed, liquid density, viscosity, liquid depth, and propeller depth have been investigated. It is shown that the experimental data obtained can be correlated in the form of a dimensionless equation the constants of which have been evaluated. Attention is directed to the fact that no critical value is found for the modified Reynolds' number term, and that the Froude factor (wave formation term) may be neglected. J. W. H.

Chemistry and Physics of Hydrocarbons.

1078. Hydrogen Fluoride, The Catalyst. Part 2. J. H. Simons. *Refiner*, July 1943, **22** (7), 189–193.—The catalytic power of hydrogen fluoride must be related to its chemical and physical properties. Those that probably govern its action in organic chemical reactions are its solvent power, its high dielectric constant, its high acidity, its great dehydrating tendency, the insolubility of the other halogen halides in it, and its great tendency to combine with itself and other substances to form molecular complexes.

The effects of anhydrous hydrogen fluoride on glass, wood, paper, human tissues, etc., has been a hindrance to its use. These effects are explained. The effect on siliceous materials is due to the formation of the gaseous silicon tetrafluoride, which escapes the site of the reaction, and thus allows it to proceed. The effect on things like wood and paper is primarily a dehydration, for hydrogen fluoride is a powerful drying agent. On rubber and many unsaturated organic chemical substances the effect is due to the powerful polymerizing action of hydrogen fluoride. The effect on human tissue is due to the fact that this very acidic substance is readily absorbed, and both the hydrogen ions and the fluoride ions are toxic.

In view of the powerful polymerizing power of hydrogen fluoride, it is very surprising that it can be used as a catalyst for organic chemical reactions to prepare desired products in very good yields and without the formation of any appreciable amount of unwanted polymers. As soon as it was demonstrated that this was possible and conditions for doing it were found and described, the way for laboratory experimentation on organic chemical reactions was opened. The advantages of hydrogen fluoride over other agents for the same or similar purposes from an engineering point of view then attracted the interest of industry. One of the reactions for which hydrogen fluoride was found to be an effective catalyst is the one known as alkylation. This is essentially the preparation of a product that contains one or more alkyl or paraffinic groups in its molecules than were in the molecules of the source material. It was found that a great variety of source materials could be alkylated, and also that a great variety of materials to supply the alkyl groups could be used. Among the latter are alkyl halides, olefins, alcohols, esters, ethers, etc. Examples of alkylation are studied to illustrate the chemistry of the reaction. Hydrogen fluoride can be used as the catalyst for certain other reactions which are related to alkylation and acylation. Examples of these are ring closures and rearrangements. An example of the latter is the Fries change. A similar type of reaction is a variation of an exchange reaction. Examples of these as catalyzed by hydrogen fluoride are: *tert.*-butylbenzene reacts with phenol to form benzene and *para-tert.*-butylphenol, benzophenone oxime rearranges to benzanilide, phenyl acetate rearranges to *para*-hydroxyacetophenone, *para*-cresylbenzenesulphonate rearranges to 2-hydroxy-4-methyldiphenylsulphone.

Hydrogen fluoride is also a useful catalyst for reactions not directly related to alkylation and acylation. For example, it is very effective in aiding sulphonation. Benzene reacts with sulphuric acid in the presence of hydrogen fluoride to form benzenesulphonic acid. At higher temperatures dephenyl sulphone is formed. Mixed sulphones can be formed by treating a sulphonic acid with another organic compound

in the presence of hydrogen fluoride. An example of this is the treatment of toluene with benzenesulphonic acid to form the mixed sulphone, *para*-tolylphenylsulphone. Hydrogen fluoride also catalyzes nitration. Nitric acid reacts with benzene at sub zero temperatures to form mononitrobenzene. Further nitration is not accomplished at the low temperature. Benzene is here used as an example of a reactant. Other substances can be sulphonated and nitrated, using hydrogen fluoride as the catalyst.

Hydrogen fluoride is also an effective catalyst in the formation of esters. Esters of acetic and butyric acids have been made by the reaction of these acids with olefins, using hydrogen fluoride as the catalyst. Ethyl acetate was also made by the reaction of acetic acid and ethyl alcohol. The reverse action—that is, the reaction of water with ethyl acetate to form ethyl alcohol and acetic acid—is also catalyzed by hydrogen fluoride. The formation of ethers, carboxylic acids, etc., is studied. The catalytic action of hydrogen fluoride is compared with that of aluminium chloride. A tentative mechanism is postulated. A. H. N.

1079. The Phase Transformations of Normal Paraffins. C. G. Gray. *J. Inst. Petrol.*, August 1943, **29** (236), 226–234.—Pure normal paraffins are found to crystallize in at least four distinct modifications: (α) hexagonal system; (β) orthorhombic system; (γ) an uncertain system which may be monoclinic or triclinic; and (δ) another uncertain system which may be either monoclinic or triclinic, but distinct from (γ). Theoretical considerations lead to the formula $T = A - B/(n-1)$ for the relationship between melting point and number of carbon atoms in those *n*-paraffins in which the α form is stable at the melting point. The formula is applicable over the range $n = 20$–36 inclusive, and is in excellent agreement with observed values. Above C_{36} the relationship between melting point and number of carbon atoms is of a different type, and the curve for melting point in this zone continues as a transition ($\alpha \leftarrow\rightarrow \beta$) in the solid phase below C_{34}, suggesting that the β form is stable at the melting point above C_{34}. The upper transition line in the zone $C_{29} - C_{33}$ is probably the continuation, as a transition ($\alpha \leftarrow\rightarrow \gamma$) in the solid phase, of the γ melting-point curve for even paraffins below C_{30}.

An equilibrium diagram is given for the melting point and solid-phase transitions of normal paraffins. A. H. N.

1080.* Design for Hydrocarbon Absorption and Stripping. W. C. Edmister. *Industr. Engng Chem.*, 1943, **35** (8), 837.—A new method is described for the solution of absorption and stripping design problems. This method is more accurate than the Kremser–Brown absorption-factor method when compared with the result obtained from a plate-to-plate calculation. J. W. H.

1081.* Heats of Vaporization. D. H. Gordon. *Industr. Engng Chem.*, 1943, **35** (8), 851.—A correlation is presented which enables the latent heat of any substance at any temperature to be calculated from a knowledge of the ratio of the critical temperature to that of water or other reference substance, the latent heat of which is known. J. W. H.

1082.* Composition of Commercial Hexane. J. Griswold, C. F. Van Berg, and J. E. Kasch. *Industr. Engng Chem.*, 1943, **35** (8), 854.—Data are given for the composition of a commercial hexane cut. These data have been obtained by the removal of benzene by nitration, and a separation of the cut into paraffins and naphthenes by extraction with aniline. The products from this extraction have been distilled in an efficient column to yield close boiling cuts, the physical properties of which have been determined for the calculation of composition. It is shown that the removal of the naphthenes greatly increases the degree of separation obtained. J. W. H.

Synthetic Products.

1083.* Brittle Points of Natural and Synthetic Rubber Stocks. R. E. Morris, R. R. James, and T. A. Werkenthin. *Industr. Engng Chem.*, 1943, **35** (8), 864.—A new apparatus for the determination of the brittle point of synthetic rubbers is described.

The method is considered to be of greater practical significance than previously described slow bend brittle tests.

Comparative results on the new apparatus are given for a large number of synthetic and natural rubbers, and the effect of softeners has been investigated. J. W. H.

Analysis and Testing.

1084. Developments in the Analysis of Hydrocarbon Gases by Means of Adsorption Fractionation. N. C. Turner. *Refiner*, May 1943, **22** (5), 140–144. *Paper Presented before Natural Gasoline Association of America.*—The method uses an adsorption column to adsorb the gas and a travelling heating device around the column to liberate the gas, which is then measured, and the plotted results give a quantitative picture of the components of the gas. The gas is driven by mercury. The sample of gas is introduced through a flow-meter into the bottom of the column. The flow-meter is used to estimate the quantity of sample taken. The best quantity to use depends somewhat on the nature of the gas, ordinary dry natural gas requiring about a 5-litre sample. After the sample is introduced, the sampling stopcock is closed and the one leading to the mercury reservoir is opened. A single switch on the panel board starts the operation, which, from this point, is fully automatic. The pulling of the switch turns on the heater, which remains stationary until the temperature reaches 750° F. At this point the elevating mechanism goes into operation and the heater gradually rises at a predetermined rate which was set on the instrument panel before the apparatus was put into operation. This rate is such that the heater travels the entire length of the column in about 8 hrs. On reaching the top of the column, the heater remains stationary for 20 mins, during which time hydrogen is introduced in the top of the column to act as a purge for the thermal conductivity cell, volumeter, and connecting tubing. At the end of this time the heater returns to the bottom of the column at an accelerated rate. Also, the mercury level in the column returns to the bottom of the column. Hydrogen follows the receding mercury, and is present in the column when the next sample is charged in. The hydrogen is generated electrolytically by the apparatus. Details of temperatures and other experimental conditions obtaining during measurements are given.

The work thus far has been largely confined to mixtures of hydrocarbons containing nothing heavier than hexane. Analysis of mixtures containing known quantities of hexane have demonstrated that this hydrocarbon can be adsorbed in the column and quantitatively recovered in the distillation. Similar runs made with samples containing known quantities of heptane and heavier hydrocarbons show that these heavier hydrocarbons cannot always be completely distilled from the column. The charcoal used in all of these, however, was full 40-min. activity. Preliminary experiments indicate that the retentivity of the charcoal can be reduced by the deposition of salt on capillary surface of the carbon, so that hydrocarbons as heavy as decane can be quantitatively removed. The work on this phase of the problem is still in progress, and it is too early to reach any final conclusions, but the results so far indicate that there will be no difficulty in handling mixtures containing hydrocarbons as heavy as decane. The highest-boiling hydrocarbons which can at present be actually separated are pentane and hexane. Thus, hexane and heavier hydrocarbons will be determined as a single group. A. H. N.

1085. Gas Analysis by Means of the Mass Spectrometer. O. L. Roberts. *Refiner*, May 1943, **22** (5), 149–151. *Paper Presented before American Petroleum Institute.*—The paper described very briefly the principles and operation of the mass spectrometer. If each of the molecules of a mixture of gases is electrically charged with a single positive charge, and if each of these charged molecules is set in motion by virtue of the attraction of a nearby negatively charged body. then these moving positively charged molecules or positive ions constitute an electric current. If these positive ions are made to traverse a path through a magnetic field of uniform strength, then each ion will be deflected, and the amount of the deflection will be a function of the mass of the molecule. By this means a stream of molecules of different masses can be separated according to their mass.

In the instrument the gas is admitted into a chamber. A small fraction of the gas is

given a positive charge due to bombardment by electrons which are liberated from a heated filament. The energy of the bombarding electrons is high enough to break some of the molecules into fragments which are also positively charged. The positively charged ions are accelerated towards the electrodes, and after passing through these electrodes enter the semi-circular analyzer tube with a high velocity. The externally applied magnetic field deflects these positive ions, and, by varying the electric field ions of each mass, can be caused to impinge on the collector electrode. At this point the number of ions which reach the collector/unit of time is measured by a recording mechanism. The record produced is a series of peaks which are graphical representations of the relative amounts of ions of each mass. The analysis of the mixture can be determined if the instrument has previously been calibrated with pure compounds. For any given hydrocarbon the particular fragments formed, and the ratio of the amounts of the particular fragments formed, are functions of the number and configuration of the atoms in the molecule. It is imperative that the design and construction of the instrument be such that the spectrum obtained from each component of the mixture be a function of the percentage of each component in the mixture.

Since the record produced by the instrument for a gas mixture is a summation of all the individual components present in the mixture, if the spectrum for a pure hydrocarbon is known, its contribution to the composite gas mixture spectrum can be determined. Interpretation of the composite gas-mixture spectrum involves separating the individual contributions made by each of the components and determining the amount of these contributions. The interpretation of spectra obtained from mixtures containing light hydrocarbons is relatively simple, and the complexity of the interpretation increases as the molecular weight of the hydrocarbons increases. At present the mass spectrometer has ânalyzed mixtures containing C_5 hydrocarbons, although not all the C_5, C_7, and C_8 hydrocarbons have been determined. Before this can be done pure hydrocarbons must be obtained for calibration purposes. A 10-component mixture containing methane, ethane, ethylene, propane, propylene, normal-butane, *iso*-butane, *iso*-butylene, butene-1, and butene-2 requires less effort in interpretation than would a mixture of five isomeric C_6 hydrocarbons. The difference in ease of computation lies in the fact that in the first mixture many of the components can be determined separately, whereas in the latter mixture the determination of the composition of the mixture requires the solution of five simultaneous equations. In general, an experienced operator and computer who is confronted with making gas analyses of all types would average about 2 hrs./sample. This includes the time of running the instrument and computation as well as making the determination. Many samples containing hydrocarbons from C_1 to C_4 inclusive can be analyzed in about ½ hr. One-tenth of a ml. of gas is ample for several check determinations and analyses.

A. H. N.

1086. A Simplified Lubricating Oil Oxidation Stability Test. R. E. Hersh, N. D. Lawson, E. F. Koch, M. R. Fenske, and C. E. Stevenson. *Refiner*, July 1943, **22** (7), 197g205.—A discussion of the requirements to be fulfilled in an oxidation test before it can be considered for general use is made. The importance of making the test and the conditions under which it is made representative of engine deterioration are stressed. The apparatus and the thermostat are described in detail. The oil charge, 100·0 ± 0·5 gms. (0·22 lb.), is placed in the oxidation tube together with the sheet-iron and copper-wire catalyst prepared as described in the paper. The tube is then placed in a well in the thermostat, the air-inlet tube with two lacquer slides and the thermocouple are then inserted, and 1 hr. is allowed to bring the oil approximately to the oxidation temperature (347° F. or 175° C.). During this time no air is bubbled through the oil. The end of the hour allowed for warming-up is taken as zero time for the start of the run, and the air rate is then adjusted to 10 litres/hr. The oil temperature is measured and recorded at least once in every eight-hour period. In determining the average oil temperature during the run, values measured before the end of the first hour of oxidation are not used. At the end of the oxidation period the air inlet tube and lacquer slides are removed and the effect of oxidation is measured in terms of the following five factors: (1) lacquer formation; (2) oil-insoluble matter; (3) oil-soluble, *iso*pentane-insoluble matter; (4) viscosity increase; (5) neutralization number.

As a preliminary step in the analysis of the oxidized oil, it is necessary to provide a

clarified oil sample, or one which has been substantially freed from oil-insoluble material. This operation is performed by filtration through Corning fine porosity (*F*) sintered glass filters (suitably those of 30-millilitres capacity). Filtering is done at least 24 and not more than 72 hrs. after the oxidation has been completed. Just before clarification, the oil is vigorously agitated, so that a representative sample, including oil-insoluble material, may be filtered. About 40 millilitres of clarified oil are required for subsequent tests. This filtered sample will be referred to as the "clarified oil." The determination of the five criteria is discussed fully. Correlation with a Chevrolet Engine Test is also discussed. The correlation obtained in this work appears to be sufficiently satisfactory to warrant the use of the simplified stability test as a supplement to the full-scale engine testing of oils. The proposed use of the laboratory unit would be to classify the oils roughly as to their relative usefulness in the service for which they are tested. Some oils could immediately be judged unsuitable, while for others it may be desirable to impress more severe conditions in order to determine their suitability prior to subjecting them to full-scale engine or similar service tests.

A study is made of the effects of changing certain test conditions, *e.g.*, temperature or time. Finally, the application of the test for other purposes—study of corrosivity of oils on certain metals, or study of effects of oxidation inhibitors—is discussed.

A. H. N.

Motor Fuels.

1087. An Empirical Relation between Octane Number and Molecular Structure. A. Mibashan. *Refiner*, July 1943, **22** (7), 195–196.—A relation was found connecting the octane numbers of paraffin and straight-chain mono-olefin hydrocarbons with their molecular structure. The molecular structure is represented by the centralization index, which varies with the length of the chain, the kind and the position of the side-chains, and the position of the double bond. The method of calculating the centralization index is given, and the relationship between centralization index and octane number for a number of paraffins and straight-chain mono-olefins is demonstrated in tabular form.

A. H. N.

1088. Calibration of C.F.R. Reference Fuels. Sub-Committee No. 5—Engine Tests. Aviation Fuel Knock-Rating Panel. *J. Inst. Petrol.*, August 1943, **29** (236), 235.—The calibration of Secondary Reference Fuel F. 4 + 4 mls. T.E.L./Imp. Gallon and C.12 + 4 mls. T.E.L./Imp. Gallon by C.F.R. Motor Method I.P. 144/42 (T), and the 17° Motor Method I.P. 43/42 (T) is given.

A. H. N.

Gas, Diesel and Fuel Oils.

1089. Creosote Oil as a Fuel in I.C. Engines. R. J. Bramhall. *J. Inst. Fuel*, June 1942, **15** (84), A.3.—This paper gives an account of experiments started in 1932 in the use of creosote in the buses at Rochdale.

First trials were in a spark-ignition engine, a 6-ton Leyland lorry being used. Starting up had to be done by gasoline, and the engine was switched over to the creosote oil when warm. Ordinary mineral lubricating oil was first used, but after 400 miles running excessive dilution and the formation of gummy deposits were noticed. These deposits appeared to be due to the action of the phenols in the fuel and the asphaltic matter in the oil.

Castor oil was next used as a lubricant, and the trouble with deposits considerably lessened. Excessive dilution was cured by distilling the fuel to remove heavy ends and the creosote further improved by washing out the phenols.

Work was then more or less suspended until the outbreak of the present war, when experiments were started on the use of mixtures of creosote oil and petroleum fuel in compression ignition engines. The phenols in this mixture tended to cause gumming, and this was more pronounced in blends containing $< 30\%$ creosote, blends containing 30–50% creosote being somewhat better in this respect. These blends had poorer ignition qualities than straight petroleum oils, and in cold weather gave satisfactory starting only in direct-injection engines.

The whole fleet of buses now uses a creosote–fuel oil mixture with a mineral lubricating oil. The petroleum fuel oil is run into a tank and the correct amount of creosote added. After standing for 24 hrs. the mixture is centrifuged and, provided a washed creosote oil has been used, a satisfactory fuel is produced. Bench tests have been carried out, and have shown some advantages for this blend over straight petroleum fuel. Such a blend is now the standard Diesel fuel for the Rochdale buses, some of which have completed 60,000 miles without trouble. D. L. S.

Lubricants and Lubrication.

1090.* Deterioration of Lubricating Oils. J. J. Jacobs and D. F. Othmer. *Industr. Engng Chem.*, 1943, **35** (8), 883.—The object of the investigation was to examine the effect of Soybean Lecithin (commercially known as Gliddol) as an oxidation inhibitor for lubricating oils. The oxidation test used for this evaluation was the Sohio test, in which the oil is air blown in the presence of steel; a description of the standard apparatus for carrying out this test is given.

It is shown that the addition of up to 2% Gliddol has no effect on the normal inspections except that the V.I. is increased. The results of the oxidation test showed that naphtha insolubles, viscosity increase, and neutralisation number were reduced, and that in this respect it compared favourably with several commercially accepted inhibitors. J. W. H.

1091.* Development and Application of Lubricating Greases. Part I. M. W. Webber. *Petroleum*, September 1943, **6** (9), 136.—A general descriptive account is given of the properties of greases and the special problems which arise in their use. The greater proportion of the greases at present in use are of calcium or sodium soap base, and aluminium and lead soaps are quite frequently employed for special applications. Consideration of the differences between these greases shows the great importance of the metallic radicle, and much work has been done in the search for elements which would produce lubricants of improved quality. Useful results have been achieved with magnesium, zinc, barium, and lithium; the last two show the most promise.

Other developments in the formulation of greases are due to the increasing use of additives. Polymers are used to increase retention and adhesion, while chemical compounds improve anti-oxidant and anti-corrosive characteristics. Extreme pressure agents, such as sulphurized fatty oils, lead soaps, and halogen compounds, are used for the preparation of E.P. greases suitable for the lubrication of highly stressed bearings such as those in rolling-mills, and also for worm drives, steering gears, etc. The polymers used at present in the grease-making industry are nearly all of the polyisobutene type—*e.g.*, "paratac."

Other ingredients which may be considered as additives for greases are graphite, mica, lead oxide, asbestos fibre, and wool yarn. These all serve useful purposes for specific applications, and are not to be considered as mere fillers. Colloidal graphite has proved extremely useful in a number of cases for the reduction of wear, friction, and corrosion, and also for the meeting of conditions of excessively high temperature. Fillers are now used only in cheap axle-greases; they have useful qualities for use on wooden axles.

The principal changes in the actual process of manufacture have been directed towards the use of higher temperatures and pressures. The former help to control the texture, melting point, and consistency of soda-soap greases, as well as ensuring more complete dehydration and saponification. Higher pressures achieved in autoclaves are principally used to expedite the saponification of neutral fats with lime, but if the soap base is highly concentrated, great care is needed to compound with the mineral oil to avoid the formation of lumps or aggregates of soap. Now that fatty acids are in such extensive use it is doubtful if the autoclave presents any serious advantage, especially when bearing in mind the comparatively high cost of the equipment and its maintenance. A. H. N.

Special Products.

1092. Petroleum Drying Oil in Exterior Paint. E. W. McMullen. *U.S. Paint, Oil & Chem. Rev.*, 3.6.43, **105** (11), 30.—A petroleum drying oil, of which 12 million lb. were

produced last year, is in use in baking enamels, porch paints, etc., and other paints in which the dark colour is not vital, and has been examined as a part substitute for linseed oil in exterior paints. The following facts were brought out :—

(1) The incorporation of the petroleum drying oil improved levelling and gloss, even in 10% substitution.

(2) Brushing is unaffected with up to 40% substitution.

(3) Drying is slower, but is brought to normal by doubling the drier concentration, a lead–cobalt combination being preferred.

(4) Up to 40% substitution gives equal, if not superior, hardness and toughness of film.

(5) In white paints 10% substitution gives off white, 20% medium ivory, and 40% dark ivory.

In prime coats, where colour is less important, the petroleum drying oil should be of even greater utility. While complete data on exposure resistance is not available, preliminary results from accelerated and light exposure tests suggest that with substitution up to 40% and proper pigmentation the outdoor life will be satisfactory for the emergency period, resulting in considerable savings in linseed oil and in the final cost of the paint. On the other hand, exposure tests carried out by the New York Paint and Varnish Production Club (Rept. of Committee No. 9 of 12.2.43) on 50% substitution of a petroleum drying oil for 4 months in Florida at 45° F. gave unfavourable results, though these may have been due to the fact that the paints were of the camouflage type, and did not contain active pigments. Promising results are being obtained with the petroleum drying oil mentioned above in interior and emulsion paints. C. L. G.

1093. Petroleum Refining Processes Adapted to Styrene Manufacture. Anon. *Refiner*, July 1943, **22** (7), 229–231.—A very short description of the plant of Monsanto Chemical Co. is given. The censor would only permit stating that the plant " calls for the cracking of propane to produce ethylene, then alkylation of ethylene and benzol to form ethylbenzene, followed by dehydrogenation of ethylbenzene, to form styrene." Certain details of incidental components are given. A. H. N.

1094.* Mineral Insulating Oils. A. G. Assaf and J. C. Balsbaugh. *Industr. Engng Chem.*, 1943, **35** (8), 099.—A study has been made of the effect of sulphur compounds, of the type naturally associated with mineral oils, and various addition agents used as oxidation inhibitors, on the oxidation resistance and conductance of insulating oils. It is shown that the inhibitors examined did not produce high electrical losses, and that *tert.*-amyl phenyl phosphite produced the lowest electrical loss. Sulphur compounds in the concentration found in refined oils may increase or decrease the electrical losses, depending on their type. J. W. H.

1095.* Mineral Oils in Core Compounds. Anon. *Petroleum*, September 1943, **6** (9), 138.—Cores, and the use of mineral oil as binder compound in cores, are briefly discussed. The properties and specifications of oils are listed as follows : specific gravity at 60° F, 0·92–0·94 ; flash point, 155° F. min. ; fire point, 170° F. min. ; viscosity at 100° F. (Saybolt U), 140 min. ; acid value, 48–53 ; saponification value, 190 approx. ; iodine value, 140 min. In addition to this, core oils should also possess good dispersing properties so that an even coating of the sand-grains may be achieved without having to resort to an excessive amount of mixing, and they should also work clean in the core boxes. Furthermore, they should be capable of producing cores of the requisite mechanical strength, with the minimum production of smoke and gas, though this latter property is usually overlooked if it is outweighed by the advantages of using a certain oil. Freedom from objectionable odours during drying and baking of the moulds is by no means the least desirable feature of a good core oil, and in this respect, as well as in their good " shelf-life " properties, most mineral oils will be at an advantage over vegetable and animal oils. A. H. N.

Detonation and Engines.

1096. Extending Camshaft Operating Life for Increased Engine Power Output. F. Noltimier. *Refiner*, July 1943, **22** (7), 206–210. *Paper Presented before California Natural Gasoline Association.*—The more common forms of cam wear can be divided

as follows: (1) Pock-marks of corrosion are usually most prevalent on the front or lifting-faces having high unit pressures at point of contact with roller followers. As the percentage of total surface area destroyed is usually small, this condition does not necessarily mean that the cams are no longer functioning with a fair degree of efficiency, but, from this point on, an accelerated rate of wear on both cam and rollers may be expected. (2) A more or less smooth and even wear on both sides and top of the cam lobe may occur. This type of wear will cause an appreciable falling off in power with no ready means of ascertaining its cause or even its presence. (3) Wavy, irregularly worn places on cam faces can be easily detected. The common causes are continuous operation with excessive push-rod clearance, sticky valves with a tendency to "hang-up" at certain points, or improper valve-spring tension.

There are three principal methods of checking cam performance. The first two described have the advantage of making camshaft removal from the engine unnecessary, but do not permit such complete examination as does the third. (1) With the engine cold, so that there are no rapidly changing temperatures of parts affecting push-rod clearances, carefully set same to normal operating clearance. Arrange devices on both inlet and exhaust valves which will indicate when they start to open or become completely closed. Then slowly bar over the engine, noting at which points, in terms of degrees of fly-wheel rotation, the valve events take place. Should the fly-wheel be unmarked for valve timing, a steel tape laid around the wheel from the stationary index to H.D.C. or C.D.C. can be used to measure the intervening distance and from this can be calculated the respective valve timing. (2) While maintaining the engine "on the line" and under full load, indicator stop cards or valve cards may be taken. By using a very light indicator spring to magnify the bottom of the conventional power-card, an analysis may be made of the scavenging or exhaust valve action, the inlet or filling strokes, and the beginning of the compression strokes. From these diagrams a diagnosis of valve, air-intake, or exhaust troubles may be made. (3) A third and quite accurate method of cam checking involves the removing the camshaft from engine and placing it in a testing jog. A special dial comprising 720° of flywheel rotation for one complete camshaft rotation with an accompanying adjustable index permits direct reading of valve events as produced by the respective cam.

The paper describes the experimental results on rebuilt cams and the effects observed on engine power output. A short discussion explains certain metallurgical requirements. A. H. N.

BOOKS RECEIVED.

Handbook of the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., with classified index of instruments. Pp. 53. Scientific Instrument Manufacturers' Association of Great Britain, Ltd., River Plate House, 12 & 13, South Place, London, E.C.3.

Determinacao Quantitativa do Aluminio: sua precipitacao por Meio da Fenilhidrazina. By Wolfrando Carvalho de Moraes Bastos. Pp. 54. Instituto Nacional de Tecnologia, Rio de Janeiro.

British Standard Specification No. 1113 : 1943 for Water Tube Boilers and their Integral Superheaters. Pp. 66. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 7*s.* 6*d.*

This specification applies solely to water-tube boiler units, including superheaters, economizers, and to other parts connected thereto without the interposition of a shut-off valve, exclusive of brickwork setting, and insulation.

It does not apply to pressure parts constructed of alloy steels or of carbon steels of different qualities from those stipulated.

British Standard Specification No. 1131 : 1943 for Bronze Oil Retaining Bearings. Pp. 7. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2*s.*

This is a war emergency standard applying to bronze bearings having oil retaining characteristics. Its object is to bring about a simplification in the variety of types and sizes of bearings, and so to facilitate more rapid and economic production by concentrating the supply and demand on a simplified range of standard sizes.

This Standard covers cylindrical type bearings; further specifications to be issued later will deal with flanged bearings and thrust washers.

Standard Methods for Testing Tar and its Products, Revised Sections on Carbolic and Cresylic Acids, Acid Wash Test and Colour Standards of Refined Lower Boiling Products, Notes on the Procedure for the Determination of Anthracene in Unrefined Crude Anthracene, and a special war-time test for the Determination of the Chlorine Content of Creosote Oil. Standardization of Tar Products Tests Committee, 116, Piccadilly, London, W.1. Price 7*s.* 6*d.*

The Twenty-fifth Anniversary of the Academy of Science of the U.S.S.R. Pp. 248. Academy of Science of the U.S.S.R., Moscow. *In Russian.*

This book contains a report of the meetings held in connection with the celebration of the twenty-fifth anniversary of the Academy of Science of the U.S.S.R. In his opening speech the President of the Academy, V. L. Komarov, gives an account of the achievements of the Academy and of Russian scientists during the period under review, and in the following speeches this is amplified by a more detailed account of the activities of the various branches.

Of interest to members of the oil industry are sections on Oil Prospecting in the Caucasus and East Russia, the Chemistry of Petroleum, and Synthetic Oil Research. There are also reviews of improvements in technique in various branches of the industry, and mention is made of the new regions of the U.S.S.R. in which oil is being produced.

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Geology and Development.

1097. Proven Reserves Continue Decline with Important Discoveries in Three Areas. W. V. Howard. *Oil Gas J.*, 29.7.43, **42** (12), 90.—During the first half of 1943 discoveries and extensions are estimated to have added 437,963,000 brl. to reserves, or 271,807,000 brl. less than the production in the same period. Ellenburger discoveries in Winkler County, Texas, may lead to an improvement later this year, and it seems likely that in 1943 the discoveries will be about 300,000,000 brl. below the production. This year discoveries have exceeded production in Wyoming, Upper Gulf area of Texas, North Louisiana, Kentucky, and Ohio.

In District 1 the only Pennsylvania grade discovery was in Muskingum County, Ohio. In Ohio, as in eastern Kentucky and the Appalachian fields, the main interest is the discovery of gas, and a fair measure of success has been obtained in Ohio, but the new supplies are not adequate. Six new pools have been found in the West Kentucky sector of the Illinois basin. Most of them produce from the Chester, but one gives oil from the Mansfield (Pennsylvanian) and another from the McClosky. In Illinois the new pools were in the old producing area within the basin.

New fields continue to be found in the northern sector of Michigan. A well found oil in the Bartlesville of Atchison County, Missouri, in the Forest City basin, but it was not completed as a commercial producer. The Carmi pool was the centre of interest in Kansas. It lies well down the flanks of the Central Kansas uplift, and may be on a new trend. On the other side of this high two discoveries were made in Saline County, one in the Mississippi lime and the other in the Viola. The West Edmond field opened in Oklahoma seems to be a stratigraphic trap. A well in eastern Mississippi reports 100 ft. of oil-saturated Tuscaloosa sand, which is correlated with the Woodbine. It has yielded oil at Tinsley and Natchez. Seventy-six wildcats gave only four oil and two gas discoveries in North Louisiana and Arkansas. Oil has been found in the Katy field of the Texas Gulf Coast, but the quantity associated with this gas-distillate field, which has a 45-ml. perimeter, is uncertain. A large structure has been opened in the old Slick pool of Goliad County. Chief attention is being paid to the Lower Cretaceous pays in East Texas, and finds have been made at Manziel, New Hope, and Scroggins.

The Ellenburger discoveries of Winkler County, West Texas, are deep and expensive, so that development may be slow. The Embar-Tensleep production of the Oregon Basin of Wyoming has been followed by drilling in the Elk Basin which has revealed 6 sq. ml. of virtually proven production. The Sundance has proved to be an important producer at Steamboat Butte. Two oil-fields and four gas-fields were found in California, the Pleasant Valley field producing from the Eocene.

Tables give by States and districts the proven oil reserves on 1st July, 1943.

G. D. H.

1098. Crude-Oil Production Responds to Rising War Requirements by Setting New Peak. W. V. Howard. *Oil Gas J.*, 29.7.43, **42** (12), 93.—During the first half of 1943 crude production in U.S.A. reached the record level of 709,770,000 brl., 31,232,000 brl. more than in the corresponding period of 1942. Noteworthy increases amounting to 57,909,000 brl. were recorded in Texas, California, and Kansas. Oklahoma fell to the fourth place among the producing States. Illinois and Michigan also suffered declines. Marketing and transportation effects led to increases in the coastal district of Texas, East Texas, and the Panhandle. The West Texas decline was due solely to artificial causes, and that of South Central, West Central, and North Texas was the result of natural causes.

Arkansas, Colorado, and Wyoming appear likely to reach new peaks.

The present U.S. production is not a sign of steady growth, but to some extent the result of the over-production of certain areas in order to meet current demands which it may not be possible to satisfy much longer from domestic sources.

The annual production for the years 1937–1942 inclusive, and the production during the first halves of 1942 and 1943 is listed by States. G. D. H.

1099. Major Fields Called Upon to Supply Disproportionate Share of Nation's Oil. W. V. Howard. *Oil Gas J.*, 29.7.43, **42** (12), 94.—The 75 largest U.S. fields increased

their production by 34,539,000 brl. in the first half of 1943, while the total U.S. production was only 31,232,000 brl. above that for the first half of 1942. Of the 75 fields, 23 showed a decline of 25,503,000 brl., so that the remaining 52 fields increased their production from 225,729,000 brl. to 285,751,000 brl. This year the 75 largest fields have produced 53·3% of the U.S. oil for the half-year, compared with 55·1% in the corresponding period of last year. This year 84 fields are producing more than 10,000 brl./day, and such fields account for 57·8% of the country's oil.

In the Permian basin and Wyoming major fields have been or are being developed which can take up some of the burden of greatly increasing production, but the type of oil and remoteness from transportation centres raise additional problems.

The major fields are listed with their age and output during the first halves of 1942 and 1943. Fields which have been added to or removed from the list this year are noted. The fields are also grouped according to their outputs, and according to the production trends. G. D. H.

1100. Era of Abundant Production Fading. D. R. Knowlton. *Oil Gas J.*, 29.7.43, **42** (12), 103.—For the past fifteen or twenty years it has been necessary to restrict oil production to some extent, but now the era of plenty is being succeeded by one of scarcity and unmet quotas. Except for a few fields on the Gulf Coast and in West Texas, every U.S. field is producing at or above its maximum efficient capacity. There is a fear that the present high rates, and perhaps higher rates in the near future, will damage producing ability and ultimate recovery. In Kansas the high rates of flow have been accompanied by the appearance of water in Arbuckle limestone wells which supply 80% of the State's oil. The present rate of 780,000 brl./day seems to be California's maximum efficient capacity, although two years ago there were claims that it could produce 3,000,000 brl./day. Arkansas, Oklahoma, Michigan, Mississippi, and Illinois are producing at higher rates than appear desirable from the point of view of operating efficiency, and the same is true of most of Texas and Louisiana.

In June the crude production was about 3,980,000 brl./day, and in July the rate may be 100,000 brl./day higher, with a further rise probable in August.

Larger amounts of steel are being allotted to the producing branch of the oil industry, and it may now be possible to drill some of the deferred wells. In some areas closer spacing is being allowed—California, eastern Kansas, eastern and southern Oklahoma, North Texas, Cut Bank, and Kevin-Sunburst.

Apart from the discovery of new fields, the most important source of increased productive capacity lies in secondary recovery. 3,000,000,000 brl. of oil recoverable by secondary methods is believed to be available at existing or slightly higher prices. In water-flooding it seems that about 50% of the reserves are obtained in the first two years of operation. G. D. H.

1101. All Methods of Discovery Are Needed to Reverse Trend of Petroleum Reserves. W. B. Heroy. *Oil Gas J.*, 29.7.43, **42** (12), 105.—From 1900 to 1925 the volume of proved reserves was generally near the current annual production, but for the period 1925–1931 the volume of new reserves discovered substantially exceeded production. In 1930 East Texas was discovered, and for several years it overshadowed all other development. In 1932 and 1933 less oil was discovered than was produced. The advent of proration had a stabilizing action, and in the 1934–1938 period 9,600,000,000 brl. of oil was discovered, and 5,800,000,000 brl. was produced. At the end of 1938 the total reserves were 17,400,000,000 brl., or more than fourteen times the 1938 production. Much of the rapid building-up of reserves was due to the application of geophysics, and in the latter part of the 1934–1938 period an average of 250 geophysical crews were constantly at work.

The reserves found in 1939 were about a third of those found in 1938. In 1940 nearly as much oil was found as was produced, but 1941 fell back to the 1939 level. It seems likely that the 1942 discoveries will provide reserves equal to about a half of that year's production. In this last period production was about 5,400,000,000 brl. and discoveries may not have exceeded 3,900,000,000 brl., although at its end about 330 geophysical crews were in the field. 44% more wildcats were completed in 1941 than in 1937, and there was a corresponding increase in the number of successful wells and fields found. However, the size of the new fields fell from an average of 11,000,000 brl. in 1938 to 2,000,000 brl. in 1942.

It seems probable that most of the structural traps containing important oil fields have been located, due to the efficiency of geophysics.

At the present rate of wildcatting it seems that about 3350 wildcats will be drilled in 1943, but with the existing volume of reserve added per wildcat, the discovery of a volume of oil equal to the current production would require 5600 wildcats in 1943. P.A.W. has urged the drilling of 4500 wildcats this year, hoping thereby to increase the number of random wildcats and to encourage the testing of the best available prospects. G. D. H.

1102. War Hastens New Concept on Value of Nation's Natural Gas. E. H. Poe. *Oil Gas J.*, 29.7.43, **42** (12), 106.—Return of gas to the reservoir assures to-morrow's supply of both gas and oil. Unitization has sometimes proved impossible, and an alternative method of conservation has been to shut in high gas/oil ratio production or to connect the gas to a consumer instead of wasting it. Even in California a 20% gas saving has been effected in the past year. The use of underground storage adjacent to consuming centres has proved highly successful in meeting heavy seasonal demands. The depleted Playa del Rey field is an example of such technique. In District 1 gas delivery will be supplemented by 50–100 million cu. ft./day by additional looping of a line from Texas to Michigan, and by a 120-ml. interconnection with the East Ohio Gas Co.'s properties. A 240-ml. extension will draw 140,000,000 cu. ft./day from the Hugoton field to District 2's industrial area.

Industrial research has been concentrated on the utilization of the more abundant light hydrocarbon fractions. 11% of last year's marketed natural-gas production was used in carbon-black production, and improved methods are giving increased yields.

A new condensate-bearing area, with promising potentialities, has been found in the Permian basin. G. D. H.

1103. World Production Reviving. J. P. O'Donnell. *Oil Gas J.*, 29.7.43, **42** (12), 114.—The world production in the first half of 1943 is estimated at 1,043,532,000 brl., about 4,716,000 brl. less than in the same period of 1942. Improvements of the transport situation caused production revivals in some areas which had previously shown marked declines. U.S. had a rise of 25,939,000 brl., which offset about 80% of the decline shown elsewhere in the world when compared with 1942 figures. U.S. produced 68% of the world's oil in the first half of 1943.

Venezuelan production in the first half of 1943 was slightly over 400,000 brl./day, less than 50% of the country's proven potential. In the same period Colombia's output was only a quarter of that for the first half of 1942. Colombia has a large potential which still lacks outlet. Mexico's production in the first half of 1943 was only two-thirds of that for the same period in 1942.

The production of the Ural–Volga region is estimated to be 125,000 brl./day. The temporary loss of the fields of the western Caucasus caused the European output in the first half of 1943 to be below that for the same period of 1942.

Asiatic production may have risen in the first half of 1943 because of the greater demand for Near Eastern oil and the opportunity Japan has had to restore production in the East Indies.

The estimated outputs in the first six months of 1942 and 1943 are tabulated by fields. G. D. H.

1104. Drilling Decline Continues with Few Prospective Active Areas. W. V. Howard. *Oil Gas J.*, 29.7.43, **42** (12), 131.—Of the 7819 wells drilled in the first half of 1943, 3283 were east of the Mississippi, and of them 1791 gave oil and 637 gas. Apart from those in Mississippi and Michigan, the wells east of the Mississippi are expected to be small. A thousand producers were drilled in the Appalachian States, mostly in the Bradford field. In addition, about 900 input wells were drilled. 75% of the U.S. gas wells were in the eastern districts; the majority have a capacity less than 500,000 cu. ft./day.

Excluding the eastern States, 1430 wildcats were drilled, and these gave 181 new fields, extensions or new sands, and 31 new gas-pays. Louisiana has 15 discoveries, Texas 65, 46 of them in the north-central and south-western districts, and Kansas 35. Most of the Kansas discoveries may prove to be extensions to old fields.

About 25% of the development wells in the first half of 1943 were dry, the majority being marginal walls. Michigan, North-central Texas, Southwest Texas, and Louisiana had a disproportionately large number of dry holes.

In Kansas, the Carmi and Lindsborg fields are developing rapidly. They lie outside the main producing belt on the Central Kansas uplift. There has been considerable activity at Cumberland and Velma in Oklahoma. Nearly three-quarters of the development drilling in the Rocky Mountain area was at Oregon Basin, Cut Bank, and Kevin-Sunburst. A great part of the drilling in Illinois took place in fields discovered during the past eighteen months.

Tables summarize the wildcat and development drilling, and the total completions in the first half of 1943. G. D. H.

1105. Permian Basin Panhandle, New Mexico : Ellenburger Discoveries in Winkler County Are of Major Importance. H. F. Simons. *Oil Gas J.*, 29.7.43, **42** (12), 136.—Three new Ellenburger discoveries have opened up the entire west side of the Permian basin for Ordovician exploration. All three are in Winkler County, and two are less than 4 ml. apart, although on separate structures. The third well, completed just after the new year, was 14 ml. south-east of the others. Continued drilling in the Embar–Ellenburger pool and the Barnhart pool gave further encouragement to Ordovician development in the entire area. The search for Ordovician oil has spread throughout the entire southern half of the Permian basin ; there has been relatively little Ordovician prospecting in the northern sector.

A Clear Fork discovery on the east side of the Permian basin opened up the eastern side for deeper exploration. Most of the production in the area is from the San Andres lime. Five other discoveries in the Permian basin were relatively unimportant, the wells not being large, and producing from pays already known to be productive.

Early in 1943 P.A.W. ruled that no more gas-wells could be drilled in the Texas Panhandle area. Routine oil-well drilling continued. No important extensions were recorded. An Ellenburger test is under way in Armstrong County between the Panhandle and Permian basin districts.

Wildcatting and field work were light during the first half of 1943 in south-eastern New Mexico. The bulk of the drilling was in the Jackson–Grayburg, Square Lake, and Maljamar pools. A well in Lea County was carried to 9594 ft., and tested at many points. The most promising zone was in the Lower Permian at 4859 ft., while the Simpson showed possibilities at about 8200 ft. A small discovery was made in Eddy County.

Tables summarize the completions by fields for the first half of 1943, and the production is given for the first halves of 1942 and 1943. G. D. H.

1106. California : Record Demand Combined with Low Rate of Discovery Drops Coastal Reserves. L. P. Stockman. *Oil Gas J.*, 29.7.43, **42** (12), 142.—In 1941 California's crude reserves fell 116,162,000 brl., in 1942, 156,295,000 brl., and in the first half of 1943 about 100,000,000 brl. Two oil-fields and three gas-fields were opened in the first half of 1943. The Wheatville oil discovery is of doubtful value, but the Eocene at Pleasant Valley is quite prolific. Commercial gas discoveries were made at Lodi, Mendota, and Thornton, thus maintaining the gas reserves of the State, and it seems likely that a new deeper productive zone has been found at Rio Vista.

658 wells were completed in the first half of 1943, 525 giving oil and 14 gas. Most of the current drilling is in proved fields, especially in those giving a heavy crude. Development work is expected to increase in the second half of this year. The daily average production of 772,606 brl. during the first half of 1942 was the highest since 1929.

One of the most important undeveloped reserves is the Ford zone of the Long Beach Harbour section of the Wilmington field. The tar zone also contains much oil. The extent of the Sentous zone at Inglewood is undetermined. Several other fields have good deep-zone possibilities which have not been tested (Ten Section, Newhall-Potrero, San Miguelito, and Ventura Avenue). South Belridge still produces from the Pleistocene and Pliocene, and its productive limits have been extended. North Belridge produces from the Pliocene, Miocene, and Eocene.

A wildcat is under way on the line of folding which contains the Rio Bravo and

Greeley fields. There are several favourable structures in the Tejon district in the extreme south of the San Joaquin Valley.

The production in the first halves of 1942 and 1943 is tabulated by fields, and completion data are presented for the first half of 1943. G. D. H.

1107. Texas Gulf Coast : Discovery of Oil in Katy Distillate Field Is Outstanding Gulf Coast Development. T. F. Smiley. *Oil Gas J.*, 29.7.43, **42** (12), 147.—An excellent oil-sand has been found at Katy which was previously supposed to be a gas and distillate field only. The discovery well is 2½ ml. from the nearest gas-well, and after finding gas and distillate in three different horizons it located oil at the 6600-ft. level which had not been tested in the other wells.

Conroe, the prolific Cockfield producer, is to have a deep Wilcox test. The Wilcox gave minor oil shows in a previous test. In January the Stowell field was extended 2 ml. to the north by a well, located on geophysical and subsurface data, which reported 120 ft. of productive Frio. A Frio well was completed at a depth of 10,258 ft. to open the Hall's Bayou area in Brazoria County. A large gas-well opened the Sterling field in April. It lies 3½ ml. south-east of Ganado, and flowed 46,700,000 cu. ft./day from 4910 to 4940 ft.

Tables give a summary of the wildcat and other completions in the first half of 1943, by fields, as well as the production in the first halves of 1942 and 1943. G. D. H.

1108. Illinois : Covington, North Calvin, and Belle Rive Best New Fields. J. McIntyre. *Oil Gas J.*, 29.7.43, **42** (12), 150.—818 wells were completed in the first half of 1943, 485 being oil-wells. The corresponding figures for 1942 were 833 and 480. The most important discoveries seem to have been Covington, Belle Rive, and North Calvin. Covington has five oil-wells with an average initial production of 159 brl./day. Seven oil and four dry wells have been drilled at Belle Rive, where the initial outputs averaged 170 brl./day. The five successful wells at North Calvin averaged 106 brl./day initially. The greatest activity was at Bible Grove, Friendsville, New Harmony, Iola, Phillipstown, South Lawrence, and Walpole. Twenty-two wildcats found oil, some proving extensions, and others new fields, as at Belle Rive, Covington, North Calvin, Bennington, North Schnell, West Mount Carmel, Mount Auburn, Scheller, West Frankfort, North Phillipstown, North Hoodville, Logan, and North Herald.

The Flora pool was extended ¾ ml. to the south-west, and Phillipstown was extended 1 ml. to the north, both extensions being McClosky producers. Devonian production has been found in the old Patoka pool. Allendale and North Calvin were extended. Extensions were made at Mount Erie and Akin, a new pay being found in the latter pool. Rosiclare production has been found at South Mason, and a new pay, the Mansfield sand, has been opened at Phillipstown.

Tables give the completions and types of completions by fields, the wildcat completions, and the production and number of wells producing in the first six months of 1942 and 1943. G. D. H.

1109. South-west Texas : Major Wilcox Discovery Made in Slick Area, Goliad County. T. F. Smiley. *Oil Gas J.*, 29.7.43, **42** (12), 158.—Thirteen out of 56 wildcats succeeded in the Lower Gulf Coast area, where there were 192 completions in the first half of 1943, compared with 291 in the same period of 1942. South Texas had 190 completions, against 277 in the first half of 1942; South Central Texas had 36 completions in the first half of 1943.

In the old Slick field area of Goliad County a 249-brl. well has been completed in a thick sand, and this has been described as the largest Wilcox sand discovery in the South-west Texas. Geophysical and other data indicate that the structure is unusually large. A gas-field was found at Cabeza Creek, the discovery well having an initial open flow of 19,000,000 cu. ft./day.

Six producers have been drilled in the Hobson field of Karnes County, and oil has been found at Hondo Creek. Karnes County had two other less significant finds.

Several wildcats are drilling or to be drilled in the Rio Grande Valley. Two new fields and two extensions have been opened in Starr County, while Duval County had one new field and one new sand discovery.

Tables give by fields and counties the production in the first six months of 1943

and 1942, together with the number of wells producing on 1st July, 1942, and 1st July, 1943. Summaries are also given of the well completions and wildcats in the first half of 1943. G. D. H.

1110. Eastern Texas : Wood County Paluxy Yields Important Discoveries. H. F. Simons. *Oil Gas J.*, 29.7.43, **42** (12), 166.—During the first half of 1943 wildcatting in East Texas was centred round Wood County, due to the interest caused by the Quitman Paluxy discovery of last year. Of the five wildcats in this area one succeeded and opened the Manzial (Cartwright) pool. 25 wells (19 producers) were completed in the Hawkins Woodbine pool, and 17 wells (16 producers) in the Quitman pool. The latter pool is not yet defined in any direction.

The New Hope pool may be a major field. It produces from the Rodessa (7295–7305 ft.) and the Travis Peak (7902–8089 ft.). A Paluxy sand discovery in Hunt County has opened up a considerable area to deep production.

The Kildare pool, which produces from the Gloid lime, was extended 1 ml. northwards.

Of 62 wildcats in widely scattered areas, only four were successful. The Smackover lime, which lies below the deepest known producing horizon in this region, was attracting attention.

Tables give production and completion data by fields for the first half of 1943. G. D. H.

1111. Louisiana Gulf Coast : Deep Sands Provided More New Oil Than New Fields ; Deepest Producer Drilled. T. F. Smiley. *Oil Gas J.*, 29.7.43, **42** (12), 169.—The world's deepest production has been obtained in the De Large field, where a well flowed 5,970,000 cu. ft. of gas and an unestimated volume of distillate from 13,475 to 13,490 ft.

170 wells were completed during the first half of 1943, compared with 270 wells in the same period of 1942, and 94 wells found oil. The greatest activity was at Pine Prairie where Wilcox production has been found and Sparta lime production opened on the south of the dome. Major-scale distillate production is foreshadowed in the Erath field. All the wells are to be perforated in the 8700-ft. level, and it is reported that some of the shallower sands are even more prolific in their distillate yield than are the deep zones. Production is in the Miocene.

The Bear field was opened in April, finding production in a new Frio sand zone. Miocene production has been established on the east flank of the Napoleonville dome. The abandoned non-commercial Perkins gas-field now seems to have excellent oil prospects. It is hoped that a similar transformation may take place in the Bayou des Glaise field. Four dry holes have been drilled in the Bully Camp gas-field.

Tables give the production and completions by fields during the first half of 1943, as well as a summary of the wildcats. G. D. H.

1112. North Central Texas : Discoveries in Mississippi and Caddo Lime Maintain Production. H. F. Simons. *Oil Gas J.*, 29.7.43, **42** (12), 172.—During the first half of 1943, 433 wells were completed, but only 179 yielded oil. The most concentrated activity was in the Thornberry field which includes several lenticular sand pools.

The best wildcat completion was 4 ml. north of Archer City, the well being completed in the Caddo lime at 4881–4891 ft., with a potential of 763 brl./day. The discovery well of the Buffalo Springs pool produces from the Mississippi lime at 6011–6049 ft., its potential being 483 brl./day. Several wildcats have started in the vicinity. The Ellis pool, a Caddo lime field, was opened in January. The Peek pool is also a Caddo lime producer, with oil at 4575–4589 ft.

The Walnut Bend pool has been extended in the upper Strawn, and a deeper pay has been found in the lower Strawn. Lower Strawn and upper Bend production has been added in the Hildreth pool, which produced from the Simpson. A 12,096-brl. well was brought in in the Mississippi lime at 5985 ft. in the Joy pool. This well extended the pool ½ ml. northwards, and lies 6 ml. from the Buffalo Springs discovery.

Tables summarize by fields and months the completions during the first half of 1943, and also give the production during the first halves of 1942 and 1943. G. D. H.

1113. West Central Texas. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 174.—During the first half of 1943, 111 tests were drilled in proven areas and 43 were successful; four of the 50 wildcats found oil. The most important successful wildcat was the discovery of Mississippi lime production in the Eliasville pool. The discovery well flowed 4284 brl./day from 6 ft. of pay at 4236 ft. In June, Marble Falls production was found on the Corbett ranch in north-eastern Stephens County. The pay was topped at 3938 ft., and the well flowed at the rate of 840 brl./day.

Tannehill production has been obtained in the Patterson pool of Jones County. This field holds possibilities of Cisco production.

Tables show the production by fields during the first halves of 1942 and 1943, and the completions during the latter period. G. D. H.

1114. Oklahoma: Discovery Record for Half-Year Fails to Offset Production Decline. C. Hoot. *Oil Gas J.*, 29.7.43, **42** (12), 182.—Discoveries in Oklahoma during the first half of 1943 have offset very little of the decline in production, and a number have had discovery wells with a high potential followed by offsets with water. A fourth pay has been added at Cumberland, and finds which may become fields of major importance have been made in the Cromwell sand in Okfuskee County and in the Hunton lime in Oklahoma County. After finding the Mississippi lime dry, oil was obtained from the Layton at 100 brl./hr. in the discovery well of the Big Bend pool, which lies 6 ml. south-east of the Ponca City.

Medrano sand production was added in the south-west corner of the Cement pool, and the Byars pool has been extended 1 mile to the south. Pauls Valley has been extended to the north-west, north-east, and south-east.

Total completions in 1943 are 14·8% down, and oil-wells 18% down. No important wells have been drilled this year in the Anadarko basin and western Oklahoma, and operations in North-east Oklahoma have slackened considerably. In this last area repressuring and water-flood programmes have been completed.

Tables summarize the completions and wildcat completions by fields and counties, respectively, and the production is given by fields for the first half of 1943 and 1942. G. D. H.

1115. Rocky Mountain Area: Much Activity Promised by Steamboat Butte and Elk Basin Discoveries. T. R. Ingram. *Oil Gas J.*, 29.7.43, **42** (12), 187.—166 wells were completed in the Rocky Mountain area during the first half of 1943, 17 more than in the first half of 1942. 108 oil producers and 23 gas-wells were drilled. The total initial production of the completions was 21,008 brl./day. Of 26 wildcats, eight found oil and three gas. The outstanding oil discovery was on the Steamboat Butte structure, where a 623-brl. well was completed in the Sundance sand. The well was originally intended to test the Tensleep, which produces at Pilot Butte to the north.

The Elk Basin field is an old Frontier producer, and last year the Tensleep gave a 100 brl./hr. well. The Tensleep producing area is probably 4 ml. long and 1–2 ml. wide, with its limits still undefined. 12 ml. east of Elk Basin a Madison discovery has been made which showed 840 brl./day initially. Madison oil was also found in the Oregon Basin field. Gas was found on the Douglas Creek structure, while the Fulcher Basin gas-field was extended.

Tables summarize the drilling and wildcatting by fields, months, and counties, and show the production by fields in the first half of 1943. G. D. H.

1116. North Louisiana, Arkansas: Haynesville Development Continues Most Important in Sabine Area. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 193.—Probably the most important development in North Louisiana and Arkansas in the first half of 1943 was the expansion of the Haynesville pool, which produces from the Pettit lime at an average depth of 5450–5475 ft. Of the three successful wildcats in North Louisiana in 1943 only that between the Clayton gas-field and the St. John pool was a good well. Major extensions or new pays were found at New London, Nick Springs, Midway, and Stephens in Arkansas. Geophysics is said to have revealed a few promising areas in Arkansas.

119 wells, 70 of them oil producers, have been completed in Arkansas during the

first half of 1943, and 151 wells, with 60 oil-wells and 18 gas-wells, in North Louisiana. North Louisiana had five successes out of 44 wildcats, and Arkansas one out of 32.

Tables give completion, wildcat, and production statistics. G. D. H.

1117. Mississippi. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 194.—16 ml. north-west of Waynesboro a wildcat has penetrated 100 ft. of oil-saturated Tuscaloosa sand at 6760 ft. A well in Adams County has found oil in Wilcox cores between 4000 ft. and 4200 ft.

At the beginning of the year oil-flow at the rate of 360 brl./day was obtained in the Tuscaloosa at depths of 10,281–10,285 ft., 6 ml. south-west of Natchez, in Adams County, but tests at lower levels permitted salt-water intrusion.

A monthly summary of the completions is appended. G. D. H.

1118. Michigan : New Fields in Northern Area Hold Up Production. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 197.—246 wells were completed in Michigan during the first half of 1943, 96 being oil-wells and 13 gas-wells. In the corresponding period of 1942 there were 333 completions, with 170 oil-wells and 28 gas-wells. The Evart, Fork, Richfield, and Prosper pools in Osceola, Mecosta, Roscommon, and Missaukee Counties, respectively, were opened in the second half of 1942, and did much to increase the northern crude output from 7,342,000 brl. in the first half of 1942 to 8,311,000 brl. in the same period of 1943. In the southern district the output fell from 2,933,000 brl. in the first half of 1942 to 2,215,000 brl. in the first half of 1943.

Early in 1943 Gordon and Rowmoor 1 Reams in Missaukee County produced 67 brl. in the first hour from the Dundee at 3816 ft., and on the Enterprise structure a further Dundee test gave oil, but the rate soon declined. Four miles north of the Winterfield shallow gas-field a well came in at 3,650,000 cu. ft./day from the Michigan stray gas-sand at 1285 ft.

The Ohio Oil Co.'s 1 Zimmerman in Osceola County has produced at a good rate from the Dundee at 3829–3834 ft. The Aetna-Prosper field was opened by a 1250-brl. well in the Dundee at 3835–3837 ft., but a second well was dry. South of the Woodville pool a well in Goodwell Township came in at about 650 brl./day in the Traverse at 2722–2732 ft.

The Fork field has been extended about ½ ml. to the South, and North Winterfield was extended a mile to the south-east. The extension well produced 4,000,000 cu. ft. of gas/day at 1270 ft. A 425-brl. well was completed in the Dundee at 2800 ft. in the Kawkawin pool.

Tables give by fields the production in the first halves of 1942 and 1943, and the number of wells operating on the 1st July in both years; and the completions by fields and months, as well as the wildcats by fields. G. D. H.

1119. Canada : Rapid Extension of Fort Norman Gives Canada Second Large Field. V. Lauriston. *Oil Gas J.*, 29.7.43, **42** (12), 198.—In the first half of 1943 the Fort Norman field has provided the outstanding development in Canada, and is now the Dominion's second largest field. The drilling was undertaken by an arrangement between the Canadian and U.S. Governments, and a pipe-line to Whitehorse in the Yukon Territory is planned, together with expansion of the refining facilities. During the first four months of 1943 the output was 57,729 brl., compared with 131 brl. in the same period of 1942. In April, 1943, the output was 19,692 brl. Pending completion of the pipe-line a number of wells are closed in. So far the limits of the producing area have not been defined.

The experimental plant for extracting oil from the Athabaska tar-sands has been taken over by the Government, and it is to be expanded.

New completions at Turner Valley have not offset the production decline of the older wells, and the output in the first half of 1943 was 4,555,545 brl., compared with 4,907,442 brl. in the first half of 1942. The field has been extended ½ ml. north of last year's limits. The most satisfactory completion this year is a well which gave 1948 brl./day initially. Drilling in Turner Valley has slackened this year, but elsewhere in Alberta the number of tests has increased. Taber is Alberta's second largest producing field, due mainly to one well. Tests in the Ross Lake area and the Blood Indian Reserve have proved negative. In an outlying area of the Tilley field

a dry hole was completed near Grantham, while a little Ellis sand production was found in another test. Attempts to find oil in outlying areas of the Kinsella gas-field have yielded a gasser at 1975 ft. Processing of the heavy oil from the Vermilion field has been resumed. Deca 2 in the Athabaska district is to test a promising oil-sand at 1651 ft. Ram River Oils 2, on the Ram River–Clearwater structure, is testing Devonian limestone oil-shows at 4250 ft. On the Jumping Pound structure, west of Calgary, a well has reached a depth of 10,332 ft.

In Saskatchewan, a well has been abandoned at 7958 ft. owing to drilling difficulties, after passing through the Madison and Devonian limestones. A well 12 ml. north and 25 ml. to the west is at 7688 ft., and is to test Madison, Devonian, and Ordovician horizons. Other tests are to be made, and in the Kamsack district, near the Manitoba boundary, thirty wells are planned to produce from a gas-sand 187–210 ft. deep.

In Ontario attempts are being made to revive the abandoned Dutton field, which has small pumping wells 400–500 ft. deep. There has been considerable drilling for gas. South-east of the Dawn field a well has had a production of 974,500 cu. ft. of gas/day. G. D. H.

1120. Eastern Fields : Discoveries Limited to Small Oil and Shallow Gas Pools. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 202.—Deep Lower Devonian tests in South-west Pennsylvania during the first half of 1943 were all disappointing. In various counties local lenses added some fair shallow gas production, and in one case oil. A 25-brl. Clarion sand well was drilled in Monroe Township, 4 ml. from the nearest oil-pool in Clarion County. An 8685-ft. dry well was drilled on the Chestnut Ridge in Fayette County. In the shallow area good gas-wells were completed, notably in Springhill Township, where three wells have been completed in the Injun sand with an initial open flow of 1,000,000 cu. ft./day.

Several Dunkard sand oil-shows were found and produced in Greene County in Monongahela and Cumberland Townships. A small gas-show was noted in the Lockport dolomite in an abandoned deep wildcat in Lawrence County. G. D. H.

1121. Two Small Fields Found in Indiana. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 205.—Only one well has been completed in the Rogers pool of Posey County. It produces from the Clore sand at a depth of 1900 ft. Three productive wells have been drilled in the North Owensville pool, Gibson County, where the McClosky is productive.

107 wells were completed during the first half of 1943, 43 producing oil, and 7 gas, while the corresponding figures for the first half of 1942 were 207 completions, 80 oil-wells, and 10 gas-wells.

The completions during the first half of 1943 are summarized by counties.
G. D. H.

1122. West Virginia. Anon. *Oil Gas J.*, 29.7.43, **42** (12), 206.—There have been no new oil discoveries in West Virginia during the first half of 1943, but for a time heavy distillate yields in some of the Oriskany tests in the Ripley district, Jackson County, led to speculations regarding probable deep sand oil. All these proved disappointing, but many good shallow sand gas-wells were obtained. In the Poca district of Kanawha County the Big lime-pool has been extended. Deep tests in the Union district, Mason County, Browns Creek district, McDowell County, Union district, Pleasants County, and Marsh Fork district, Raleigh County, failed to obtain Oriskany production. Two wells in the Pocatalico district of Putnam County have given over a million cu. ft. of gas/day. Deep tests are under way in the Dry Fork district of Tucker County and in the Tucker district, Wirt County.

The completions and types of completions are tabulated by months for the first half of 1943, with comparative totals for the first half of 1942. G. D. H.

1123.* Canadian War-time Oil Project is Herculean Undertaking. L. J. Logan. *Oil Wkly*, 9.8.43, **110** (10), 13.—Drilling at Fort Norman, previously thought to be a comparatively small field, has revealed a rich oil reserve. "Scores" of wells are said to have been successfully completed. The oil is light and has a high gasoline content. Some 42 producing wells were reported in May to have been capped pending

the construction of a pipe-line. During the first four months of 1943 wells in the North-west Territories produced 57,729 brl. of oil; the corresponding figure for 1942 was 131 brl.

Various roads are being constructed in this northern region, and the building of a pipe-line from Norman to Whitehorse has been begun. A refinery is being erected at Whitehorse, and there will be pipe-lines to points on the Alaskan highway.

The first Fort Norman well was drilled in 1921, and a small refinery made oil products for local use.

Dry gas in quantity is reported to have been found in the Fort Nelson area of northern British Columbia. This gas was struck while drilling for water 250 ml. north-west of Fort St. John.

Semi-official reports mention programmes for extensive drilling in areas adjacent to the Fort Norman field, much wildcatting in promising areas in the North-west Territories outside the Norman area, probable further testing of fields in northern Alberta and British Columbia, and geological search for potential oil-bearing areas in the Far North. Additional developments of the Athabasca tar-sands are suggested. 1,000,000,000 brl. of oil are said to be recoverable from the tar-sands accessible by open-cast workings, and it is claimed that plant capable of giving 75,000 brl. of oil per day could be erected for $50,000,000. Already oil is being extracted from the tar-sands on a small scale.

Farther south in Alberta there are two minor oil-fields, Vermilion and Wainwright, east of Edmonton. Turner Valley gives the bulk of the Canadian oil production, and in May 1943 provided 25,618 brl./day from 240 wells (Alberta's total was 26,000 brl./day from 268 wells). The producing area is 20 ml. long and about 1 ml. wide at its maximum. The wells at the northern end are much more productive than those in the centre or the south. There are 10,000 acres of gas production and 7000 acres of oil production. Two separate producing zones occur in the Mississippian at 7350–8000 ft.

The Red Coulee field extends across the Canadian border into Montana. In May it gave only 22 brl./day from seven wells. Wainwright was discovered in 1922, and has long-lived small wells in Lower Cretaceous sands. In May six wells produced an average of 56 brl./day. Vermilion also produces from the Lower Cretaceous. It was discovered in 1940, and gave 80 brl./day from 12 wells in May. The wells are about 1850 ft. deep.

The Alberta oil output is tabulated monthly by fields for the first five months of 1942 and 1943. The numbers of producing wells and completions are given.

G. D. H.

1124.* July Completions Follow June Trend: Work Off 20% for Seven Months. Anon. *Oil Wkly*, 9.8.43, **110** (10), 45.—During July U.S. well completions were at the rate of 375 per week, the June figure having been 382 per week, and that for the first five months of 1943 under 350 per week. In the first seven months of 1943, 10,248 wells were completed, against 12,835 in the corresponding period of 1942. The average depth of 3220 ft. for the 1943 completions is much less than in former years.

Kentucky has drilled 177 wells, compared with 82 in the first seven months of 1942. Colorado, Montana, Wyoming, and Kansas have each completed more wells than in the same period in 1942. Texas has completed 2230 wells, as compared with 3489 in the first seven months of 1942, and there were declines also in Louisiana (39%), New Mexico (39%), Oklahoma (15%), Mississippi (56%), Illinois (17%), Indiana (36%), Michigan (24%), Ohio (19%), Pennsylvania (35%), West Virginia (18%), and New York (2%).

The numbers of completions and completions of different types are tabulated by States for July and for the first seven months of 1943 with comparative totals for earlier months and years.

G. D. H.

1125.* New Gas-Well Reported in British Columbia. Anon. *Oil Wkly*, 9.8.43, **110** (10), 48.—A gas-well is reported to have been brought in in the Pouce Coupe district of British Columbia.

Dominion 5, at the north end of Turner Valley, is stated to be making 850 brl./day. Home Millarville 13 is under test, and will make a good producer, while Home Millarville 15 is drilling at 7300 ft. Bonaventure 1, Maryland Pete 1, and Devonian Test 1

are on test, and several more are expected to come in. In the south of Turner Valley, Brown 6 is on test and has opened up a new area for production.

Taber-Providence 1 is giving 240 brl./day, and Taber-Providence 37-18B is on test. The Deca well is nearing the productive zone in the Athabaska field. East of Turner Valley in the Heronton field a test is nearing the Madison at about 6200 ft. If this formation is barren the well will be drilled to the Devonian. G. D. H.

1126.* Gas-Flow in Canadian Test Near Athabaska. Anon. *Oil Wkly*, 9.8.43, **110** (10), 48.—6 ml. west of Athabaska a heavy gas-flow, which blew out, was struck recently in Deca 2 at a depth of 1687 ft. Several more wells have been planned in this area. G. D. H.

1127. Colombian Production Hits Peak in General South American Rises. J. P. O'Donnell. *Oil Gas J.*, 12.8.43, **42** (14), 32.—In the early part of July the Venezuelan production approached 500,000 brl./day, 25% more than the average for the first four months of 1943. However, the output is still only two-thirds of the peak value reached before marine traffic was disrupted. It is predicted that Venezuela's output will be doubled within a year. The Aruba and Curaçao refineries are now reported to be operating at or near capacity, after a long period of curtailment.

Colombia's output for June is given as 2,455,720 brl., an all-time peak monthly total, although the daily average for February 1942 (83,428 brl.) exceeded the daily average for June 1943 (81,857 brl.). The rise in Colombia's production this year has been astounding. January's total was doubled by March, and the March total almost doubled by May, while June more than doubled the May total.

In May the Dificil wildcat found oil in what may become one of Colombia's largest fields. Four producing wells have been completed at Socuavo in the centre of the Barco concession. The Casabe field, 225 ml. south of El Dificil, still lacks a pipe-line outlet. The nearness of the Dificil wildcat to the coast is important.

The Colombian production is given monthly from July 1941. G. D. H.

1128. Oil Zones of the United States : Lower Cretaceous. Anon. *Oil Gas J.*, 12.8.43, **42** (14), 68-C.—The principal Lower Cretaceous production is from fields around the margins of the East Texas basin. The oldest beds were the Hosston (Travis Peak) which produce in Arkansas and to a small extent in North Louisiana. The Sligo or Pettit limestone of the " Glen Rose " series is important on the north and east flanks of the Sabine uplift. The Rodessa has several pay-zones which give much oil and gas at Rodessa, and in other pools low on the west flank of the East Texas basin. The Paluxy, the uppermost member of the Lower Cretaceous, appears to be the most widespread Lower Cretaceous pay, and gives distillate, high-, and low-gravity crude. The Buda produces in a few small fields near the Balcones–Mexia fault zone, while the Edwards limestone is the main producing horizon farther south-west.

The Lower Cretaceous Lakota is a minor producer in the Powder River and Wind River basins of the Rocky Mountain area. The Cut Bank or Sunburst sand is the basal member of the Kootenay, laid down in a sea advancing from the north. It is the main pay at Cut Bank and a minor pay at Kevin-Sunburst.

Deep drilling along the Wilcox trend in Texas and Louisiana offers good chances of finding productive Lower Cretaceous beds. The Mexican production in the Tampico–Tuxpan area is of Edwards age, suggesting a possible continuation of this productive trend with that of the San Antonio area.

At Cut Bank the former shore-line is on the down-structure side, and the upper limit of the field is a transition to impervious beds. There may be other similar reversed traps. There may be stratigraphic traps in southern Montana and northern and central Wyoming.

Deep drilling will probably locate Lower Cretaceous beds east of the Sabine uplift.

A map shows the Lower Cretaceous fields and outcrops, and areas which are deemed favourable and unfavourable for Lower Cretaceous production. G. D. H.

1129. Completions and Drilling Wells Increased in July. Anon. *Oil Gas J.*, 19.8.43, **42** (15), 105.—1552 wells were completed in U.S.A. in July, compared with 1490 in June, and 1578 in July 1942. 856 produced oil and 143 gas, the corresponding figures

for June being 796 and 158. In most districts the July figures are on a 5-week basis, and those for June on a 4-week basis.

The numbers of completions are listed by States and districts, with the total footage, and numbers of wells of different types and in different depth ranges. G. D. H.

1130. Oil Zones of the United States : Upper Cretaceous. Anon. *Oil Gas J.*, 2.9.43, **42** (17), 36-B.—The Upper Cretaceous seas invaded the continent from the north, extending into Minnesota, Kansas, and the Rocky Mountain States, and on the whole this embayment became continuously smaller. Thus the Dakota sandstone occupies the greatest area. There was still a connection with the sea in the western part of the area, and some marine beds are found in the uppermost Cretaceous and early Eocene. The basins, which lie between uplifted areas throughout this region, were thus areas of deposition, involving advances and retreats of the sea with the possible development of marginal stratigraphic traps and blanket sands on structures within the basins. The Dakota is the main blanket sand, but subsequent deformation and erosion have reduced its oil possibilities, and transformed much of it into a source of artesian water. The Muddy sand produces in fields around the Powder River and Green River basins and in Colorado, while the Frontier formation produces farther north, especially in the Powder River and Big Horn basins. The Wall Creek sands yield oil in the Powder River basin and to a less extent elsewhere in Wyoming. The Eagle sandstone is the main gas reservoir in Central and Eastern Montana.

The Chico formation of California yields gas, and is believed to have oil possibilities. The Gulf Coast area had three major embayments in Upper Cretaceous times. In the westernmost embayment (Rio Grande basin) the Austin chalk, a weathered volcanic rock above the Austin, and stray sands in the Navarro yield oil. In the middle embayment (East Texas basin), which merges with the Mississippi embayment, the Woodbine sand, partly eroded before deposition of the overlying Eagle Ford, produces from the eastern flank of the basin, within the basin and along the Mexia fault zone. Sands in the Austin, Taylor, and Navarro produce locally.

The Tuscaloosa offers promise of production in the Mississippi embayment, and at Tinsley several sands in the Eutaw yield oil.

A map shows the Upper Cretaceous outcrop areas with indications of the oil possibilities. G. D. H.

1131.* Drilling and Production of Caribbean Nations to be Increased Sharply. Anon. *Oil Wkly*, 6.9.43, **111** (1), 33.—As a war measure the P.A.W. has approved a stepping up of the oil output in the Caribbean area, where a production of 1,134,000 brl./day is expected by the beginning of 1945. This will involve an increase of several hundred thousand barrels/day in the production of Trinidad, Venezuela, and Colombia. The drilling of 600 wells has been authorized in these three countries, thus permitting a doubling of the present drilling rate. The distribution of the increased output is 70,000 brl./day in Colombia, 60,000–65,000 brl./day in Trinidad, 370,000 brl./day in Eastern Venezuela, and 630,000 brl./day in Western Venezuela. There is some doubt about the ability of Eastern Venezuela to achieve this increase.

The refinery capacity of the Caribbean area is about 650,000 brl./day, and 350,000 brl. of crude/day may have to go to U.S.A. for refining when the production attains its expected rate.

The Petroleum Reserve Corporation has been formed to investigate and carry out, with Army and Navy approval, whatever foreign projects it finds desirable in assuring sufficient oil supplies for fighting the war over the whole world. It will be interested in all branches of the industry.

Expansion of operations in Venezuela and Colombia will no doubt be carried out by private companies, but as a war measure the U.S. Government has recently undertaken a programme of aiding in the revival and expansion of the Mexican oil industry.

There has been some recovery in the Colombian producing rate, which had fallen from 67,000 brl./day in 1941 to 7000 brl./day early in 1943, mainly due to decreased exports. Similar conditions caused the Venezuelan output to fall from 610,000 brl./day in 1941 to 300,000 brl./day in the second half of 1942. The Venezuelan output averaged about 400,000 brl./day in the first half of 1943. Mexico consumes 66,000 brl./day, and the output has averaged less than 90,000 brl./day in the first half of 1943. In 1941 Mexico produced an average of 113,000 brl./day. G. D. H.

1132.* Permian Basin Assumes Greater Importance as a Source of Oil. H. H. King. *Oil Wkly*, 6.9.43, **111** (1), 43.—Fourteen structures in the West Texas part of the Permian basin have from one to 85 Ordovician wells producing, five areas having been added in the past fifteen months. The latter lie on the west flank of the central platform. The majority of the Ordovician fields are not productive in the regular Permian. Recent discoveries have been 7800–10,650 ft. deep. Hard beds make drilling slow in places, and Ellenburger wildcats are estimated to cost $12–$15/ft. overall.

Ordovician producing possibilities were shown first at Big Lake in 1928, when wet gas was found at 8525 ft., and later the well gave as much as 5000 brl./day of oil. Here 26 Ordovician producers have averaged over 1,100,000 brl. each to date.

In 1936 Simpson, and later prolific Ellenburger, production was found at Sand Hill. Ordovician production was found at Apco-Warner in 1939 and at Abell in 1940. Heiner and Wentz were added to the Ordovician list in 1941, but do not seem outstanding, and the latter has shown Cambrian production. On the west flank of the central platform Ordovician production has been found at Monahans, Embar, and Kermit, the discovery well in the last field having a potential of 6788 brl./day and over 131 ft. of oil-zone. 16½ ml. north of east from Monahans is the Wheeler field, another Ellenburger producer.

A test in Lea County, south-east New Mexico, found non-commercial oil in the Simpson and Ellenburger. A test in Roosevelt County entered granite without meeting Ordovician.

Some of the Ordovician areas yield sweet oil comparable with Mid-Continent grades.

G. D. H.

1133.* Deep Discoveries in West Texas Add New Oil Empire. Anon. *Oil Wkly*, 6.9.43, **111** (1), 57.—Recent important deep strikes in the Lower Permian and Ordovician make it appear likely that numerous deep fields will be found in West Texas under established pools producing from shallower beds, and also in structures which are dry in these shallower beds. The original Ordovician producing area of West Texas has given an average of 700,000 brl./well, and there are indications that recent discoveries will be equally satisfactory. The Ordovician crudes are sweet and of high gravity, unlike the sour Permian crudes.

The discoveries have already increased the amount of wildcatting, and the deep drilling campaign is likely to expand. Pipe-line proration has been lifted and the capacity of some pipe-lines increased. Consequently production allowables have been increased in recent months. Additional outlet facilities are planned.

Tables give West Texas Ordovician development, production, and reserve data by fields, and a list of the West Texas Ordovician discovery wells with initial production, producing depth, and the top of the pre-Permian markers. The West Texas Ordovician failures are listed with the location, elevation, depth of pre-Permian markers, total depth, and completion data. A map of the Permian basin shows the dry holes, and Permian and Ordovician producing areas.

G. D. H.

1134.* New Russian Oil-Fields of Ural–Volga Area Highly Promising. J. Scott. *Oil Wkly*, 13.9.43, **111** (2), 14.—Russian authorities estimate the reserves of the Ural–Volga region at 19,413,000,000 brl., or 32% of the total Soviet reserves, which are said to be 56·1% of the world's reserves. Oil production in the Ural–Volga region began in 1929 in the Perm district, and in 1931 deep wells were drilled in the Ishimbaevo region. In 1934 the production was 360,000 brl., a new field having been found in the Ishimbaevo region, and one at Syzran. In 1935 oil was found at Krasnakamsk while drilling for water, at Tuimaz and Buguruslan in 1937, and at Severokamsk, Polazna, and in the Ishimbaevo area in 1938. By 1939 twelve fields were producing commercially, and 28,760,000 brl. of oil had been produced.

The oil from the Ural–Volga region has a high benzine and sulphur content, and it comes mainly from the Bashkirian fields around Ishimbaevo, the Tuimaz fields, the Kamensk fields, and the Buguruslan fields. Six fields are producing in the Ishimbaevo area, and in 1942 the output was 40,000,000 brl. The oil is in limestone at depths of 1000–2950 ft. There are two oil horizons about 50 ft. apart at Tuimaz, at depths of 3450–3775 ft. Four fields are exploited in the Perm area (Chusovsky Gorodok,

Krasnakamsk, Severokamsk, and Polazna). The last three are in an area, about 35 ml. long, which has good possibilities.

The Buguruslan field covers about 4000 acres, and produces from a sand at a depth of 1000 ft. The Syzran field and the Stavropol field, 35 ml. to the north-east, are similar. In 1938 they produced 544,000 brl. of oil. There are several other fields in this area. The Syzran field covers 5000 acres, and produces from two zones, one at 1650–2000 ft., and the other, the principal oil zone, at 3250–3400 ft.

A map is appended. G. D. H.

1135.* Wells Being Completed and Capped at Fort Norman. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—Recently the twenty-fourth well was completed at Fort Norman. There are three more producers on two islands in the river, and another on the opposite shore. A few wells have been drilled up and down the river miles from the location of the discovery well on the river-bank at Norman wells. They have been dry or have produced only small quantities of oil. G. D. H.

1136.* Norman Produces 89,929 Barrels in Half-Year. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—During the first six months of 1943 Canada produced 5,037,870 brl. of oil, compared with 5,240,038 brl. in the same period of 1942. The North-west Territories, mainly producing from the Fort Norman wells, gave 89,929 brl. in the first half of 1943 and 9674 brl. in the corresponding period of 1942. The New Brunswick output was 13,713 brl., and that of Ontario 66,737 brl., compared with 12,017 brl. and 73,865 brl., respectively, in the first six months of 1942. Alberta provided 4,867,491 brl. in the first half of 1943 and 5,144,482 brl. in the first half of 1942.

In June, Alberta produced 793,022 brl. of crude and gasoline, 777,761 brl. being from Turner Valley, 720 brl. from Red Coulee, 1455 brl. from Wainwright-Ribstone, and 13,086 brl. from other fields.

24,274,382,000 cu. ft. of gas was produced during the first half of 1943, the output in the first half of 1942 having been 23,444,782,000 cu. ft. G. D. H.

1137.* Four New Drilling Wells at Vermilion, Canada. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—The Vermilion field now produces about 500 brl./day from wells which are about 1700–1900 ft. deep. Four new wells are to be begun shortly. G. D. H.

1138.* Taber Field Output Over 100,000 Barrels. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—The Taber field has now produced over 100,000 brl. of oil, about half of it having been obtained this year. Some 60% of the total has come from the discovery well, Taber-Providence 1. G. D. H.

1139.* Drilling Is Planned for Taber Field in Canada. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—During July the Taber field of southern Alberta produced 8956 brl. of oil. Mid-Continent Oil and Gas, Ltd., which holds the largest acreage of any independent company in the field, has let a contract for drilling two wells immediately. G. D. H.

1140.* Development Is Active in Western Canada. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—The Ram River well has been producing at the rate of 33 brl./day, flowing by heads. The well is to be acidized. It is thought to be producing from the Devonian limestone. Locations have been made for two more wells.

At Del Bonita, Pacific Oil and Refining Company's No. 1 has reached a depth of 4300 ft.

Survey parties are said to be at work over a wide area in the Three Hills area of Alberta. G. D. H.

1141.* Deep Drilling Planned in Northern Ontario. Anon. *Oil Wkly*, 13.9.43, **111** (2), 55.—The testing of large oil-shale deposits in the Moose River basin, James Bay district of Northern Ontario, is planned. A 1500-ft. well may be drilled to test the oil possibilities of the district. G. D. H.

1142.* Completions Are Up Slightly in August to New 1943 High; Off 16% for Year. Anon. *Oil Wkly*, 13.9.43, **111** (2), 56.—An average of 408 wells per week were

completed in U.S.A. in August. The rate was 12 wells higher than the July weekly average, and 18 wells higher than for August 1942. 12,367 wells have been completed during the first eight months of 1943, compared with 14,785 in the corresponding period of 1942. While some districts have shown increases in drilling this year, the country as a whole has shown a 16% decline. California has completed 1048 wells, compared with 486 wells in the first eight months of 1942. The average depth of the 1943 wells in California is 3200 ft., whereas in 1942 the average depth was 4267 ft. This year rises in completions have taken place in Arkansas (3·5%), Kansas (2·1%), Colorado (160%), Kentucky (145%), and Wyoming (46%). Texas has had 31·5% fewer completions than in the first eight months of 1942, Louisiana 38% fewer, Mississippi 55% fewer, Pennsylvania 33% fewer, and New Mexico 41% fewer.

A table gives by States a summary of the completions in August, and in the first eight months of 1943, with comparative figures for earlier months and years.

G. D. H.

1143.* Wildcatting in August at Highest Level of Year. D. L. Carroll. *Oil Wkly*, 20.9.43, **111** (3), 11.—384 wildcats were completed in U.S.A. in August, 88 more than in July and 46 more than in May, the previous record month. 52 oil producers were completed, one distillate producer and eight gas-wells. Illinois had 17 new oil-wells, Texas 11 oil- and two gas-wells, Oklahoma six oil discoveries and two gas discoveries, and Kansas seven oil finds.

Up to the end of August 2316 wildcats had been completed in 1943, 419 of them being producers. 780 were drilled in Texas, 331 in Illinois, 314 in Kansas, 210 in Oklahoma, 147 in Michigan, and 138 in California.

The rate of discovery of new oil-fields is 12·5% below the 1942 figures; new pay discoveries are 24·5% down.

Tuscaloosa sandstone production has been found in North Louisiana in the new Holly Ridge field, Tensas Parish. This opens a new trend. The single August distillate discovery was a 1-mile extension of the St. Gabriel field, South Louisiana, where a new but thin Frio pay was tapped at 9700 ft.

A Clear Fork lime discovery was made to open the Union field in Andrews County, West Texas, the single well indicating a reserve of 320,000 brl. The North Hilger field of Reno County, Kansas, found 100 ft. of oil-saturated Viola limestone below 4099 ft. The Maplegrove field of Illinois has been extended ½ ml. to the south-east by a 758-brl. McClosky producer. A 480-brl. well in an unidentified Eocene sand has been put down in the Raisin City area of California. The Rio Vista gas-field has been extended by a 5,700,000-cu.-ft. well. There are several pay-horizons in a 650-ft. zone, which is believed to be co-extensive with the Upper Emigh gas-zone.

A new pay in the Dakota sandstone has been opened in the Cole Creek field of Wyoming. This is at 7931 ft., and adds about 320 acres of production.

The August discovery wells are listed with depth, producing horizon, initial production, structure, etc., and a table gives a summary of the wildcatting results by States in August, and during the first eight months of 1943. G. D. H.

1144.* October Crude-Oil Production Order 4,638,000 Barrels Daily—New High. Anon. *Oil Wkly*, 20.9.43, **111** (3), 43.—P.A.W. certifications call for the record output of 4,638,700 brl./day of natural gasoline and condensate, and will be 86,600 brl. above the September certification, and 523,300 brl. more than the production in October 1942.

October allocations will absorb practically all the remaining excess efficient productive capacity in all areas except West Texas. In District 1 increases are scheduled in Pennsylvania and West Virginia; in District 2 an increase in Kentucky; in District 3, increases in Arkansas, Louisiana, and Texas; and in District 4, increases in Colorado, Wyoming, and Montana. The Texas output is scheduled to be 1,999,000 brl./day.

The scheduled productions and changes in production are given for most of the States, together with estimates of the natural gasoline and condensate withdrawals.

G. D. H.

1145.* Crude-Oil Production Continues Breaking Record. Anon. *Oil Wkly*, 20.9.43, **111** (3), 48.—In the week ending 15th September the U.S. crude production reached

a new high of 4,358,755 brl./day. This was 17,600 brl./day more than in the preceding week, which was the previous record. The Texas output of 1,838,200 brl. was a new high. Rises also took place in New Mexico, Kansas, California, Indiana, Michigan, and Wyoming. Most of the Eastern States showed decreases in output. Illinois also showed a decline. G. D. H.

1146.* Foreign Oil Operations Must Be Expanded. J. P. O'Donnell. *Oil Gas J.*, 23.9.43, **42** (20), 90.—An expansion of the foreign exploration and production activities of American oil companies will be necessary after the war, for the U.S. reserves have declined, and discoveries in the first half of 1943 were 271,807,000 brl. less than the production. Large domestic discoveries, the likelihood of which might be increased by higher prices, might correct this position. From 1932 to 1940 there was an average yearly increase of 60,000,000 brl. in the domestic demand for petroleum products, and if this rate continues to 1950, the annual requirements will be about 1,900,000,000 brl. in that year.

The U.S. oil consumption in 1939 was twice as much as that of the fourteen other major consuming countries combined, and six times as much as the consumption of the British Empire.

The U.S. Government should endeavour to secure equal and equitable treatment for American oil companies in their operations abroad. Such operations may make the countries self-sufficient as regards oil, and may also provide new industry and revenue. They may also prevent the disappearance of the U.S.A. as a major market for their oil.

U.S. companies control about 60% of the world's total reserves, British companies 25%, and Russia 10%. Outside U.S.A. American companies control 25–30% of the reserves, British companies 50%, and Russia 20%.

Excluding Russia, Latin America and the Persian Gulf will probably be the areas of earliest and most extensive post-war development, and acceleration in operations is already under way in these areas.

Half a dozen fields have been proved in Iran, and two in Saudi Arabia. Oil production has been developed in Bahrein Island, and reserves of several hundred thousands of barrels are reported after drilling in Kuwait. There are prospects of large reserves on the Qatar Peninsula.

Rehabilitation of the Far East fields will be undertaken as soon as possible.

In Russia there are large reserves in the Ural-Volga and North Central Siberian areas, as well as in the Caspian basin. New discoveries have been made in Hungary and Austria, and there may be developments in Rumania. India, Burma, Egypt, China, and Canada all have oil possibilities which do not seem to have been adequately examined. G. D. H.

1147.* Oil and Gas Fields of Jackson County, Texas. J. B. Eby. *Oil Wkly*, 27.9.43, 111 (4), 20.—Eleven oil- and gas-fields have been opened in Jackson County since the beginning of 1940, seven between 1934 and 1940, and one gas-field, the Edna pool, in 1921. Nearly half of the 20,975,479 brl. of oil produced in this area was obtained in 1942. The wells have an average depth of 6000 ft.

The beds thicken towards the coast, and this is especially true of the Anahuac wedge, the marine shale series which many geologists place just below the base of the Miocene. This wedge is 1600 ft. thick at the south-east corner of the county, and feathers out near the north-west corner. It is a lithological and not a time unit, and it directly overlies the main oil-producing sands. It shows up conspicuously in drilling and electric logs. The Anahuac wedge serves to hold much of the oil in the Upper Frio sand. A small amount of oil comes from the Catahoula at the base of the Miocene.

No salt-domes are known in Jackson County, and the main oil-field structures are anticlines (West Ranch, Lolita, Maubro), fault (Cordele, West Ganado, Ganado, Collier) and stratigraphic traps (Mauritz, West Mauritz, Harmon, Mayo). Except for Cordele and Collier all the fields produce from the Frio, in which most of the production lies between the 4500-ft. and 5500-ft. contours.

The stratigraphic traps are sand lenses and stringers, frequently without any structural bending.

A map, a series of cross-sections, and a table giving production and other statistics are appended. G. D. H.

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1148.* Mexico Has Produced 2,722,023,000 Barrels. Anon *Oil Wkly*, 27.9.43, **111** (4), 56.—Production south of the Rio Grande was initiated in 1904, and up to the end of August this year the total Mexican production was 2,722,023,000 brl. of oil.
G. D. H.

1149.* Vermilion Field Expands Rapidly. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—The Vermilion field was opened in 1939, and has now produced 23,958 brl. of oil. Twenty-one wells have been drilled this year. The wells are shallow. G. D. H.

1150.* Fort Norman Oil Beats Estimates. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—In 1941 the Fort Norman production was 23,664 brl., in 1942 82,324 brl., and in the first six months of 1943, 89,929 brl. The boundaries of the producing area are still unknown.

A pipe-line from Fort Norman to Whitehorse, Yukon Territory, where there are refinery facilities, is practically complete. The initial oil requirements of the U.S. Army in this region have been met. G. D. H.

1151.* New Canadian Field at Ram River Indicated. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—The presence of oil and gas in promising quantities has been established in the Ram River well, which has now been acidized. The oil is 40·1° A.P.I., and has a high percentage of lubricating oil. Two other wells are planned. G. D. H.

1152.* Colombia Output Up with Increased Demand. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—Colombia produced 2,450,000 brl. of oil in June this year. This is almost a record. There has been rapid expansion in output each succeeding month this year. In November and December 1942 the output was only about 6000 brl./day. The average production in 1941, when exports to Canada and U.S.A. were high, was a little over 2,000,000 brl./month.

The Casabé and El Dificil fields seem to be of considerable importance. The former now has 10 wells, and its reserve is estimated at 135,000,000 brl. It is in the same area as the Infantas and La Cira pools. G. D. H.

1153.* Prospecting is Scheduled for Northern Mexico. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—The Mexican Government intends to carry out oil exploration in the north-east, adjacent to the Texas border. Prior to 1938 extensive geological and geophysical work had been carried out in this region, and there had been limited drilling on promising prospects, a number of gas-wells having been completed by private companies.
G. D. H.

1154.* Colombia's Socuavo Field on Barco Extended to East. Anon. *Oil Wkly*, 27.9.43, **111** (4), 56.—The Socuavo field on the Barco concession has been extended eastwards by a 500-brl. well, and it now has several wells giving high-gravity oil.
G. D. H.

1155.* Alberta With More Drilling Has Less Oil. Anon. *Oil Wkly*, 27.9.43, **111** (4), 58.—At present 32 wells are being drilled in Alberta, 16 being at Turner Valley. Two are in the Kinsella and Medecine Hat gas-fields, three in the Vermilion field, and one at Taber.

The current production is 26,948 brl./day, compared with 27,054 brl./day a year ago.
G. D. H.

1156.* Alberta Drilling Sets Record During 1942. Anon. *Oil Wkly*, 27.9.43, **111** (4), 58.—In 1942, 501,940 ft. of hole was drilled in Alberta, 250,975 ft. being at Turner Valley. 496,335 ft. was drilled in 1941, 279,379 ft. in 1937, and 96,904 ft. in 1936, when crude was found at Turner Valley.

25 ml. west of McCleod, Maxmount 1 reached a depth of 9430 ft. last year.
G. D. H.

Drilling.

1157. Cementing Troubles Start During Drilling. H. F. Simons. *Oil Gas J.*, 12.8.43, **42** (14), 65.—Many causes of failure of the cement placed behind the casing to perform its proper functions are either created or are present during the drilling of a well.

The principal obstacle to a satisfactory job is the enlargement of the hole, and it may be that drilling holes to gauge will be as important in the next 10 years as straight-hole drilling has been during the past decade. This article deals with the origin of many cementing failures. No attempt has been made to describe equipment and methods used in cementing oil-wells or to detail the characteristics of the various types of cement available. No calculations are presented, because those involved have to do only with volumes.

The greatest single bar to a successful cementing job, according to one major oil company engineer who has been in charge of cementing over 1000 wells, is the fact that few bore-holes are drilled to gauge. A 7¾-in. bit may be run in the well, and all the engineer is sure of is that the hole is at least that large. How much larger it is he does not know. As the amount of cement required depends on the height behind the casing to which it is required to rise, any increase in the diameter of the well results in miscalculation. There is a tool and a method available which will give some indication as to the hole diameter throughout its length. The most positive means for measuring cavities which are not too large is the hole caliper, a set of fingers which ride on the wall of the hole while their position (and the diameter of the hole) is recorded at the surface. This tool has other uses, but it is a major contribution to successful completion of a well when it measures the diameter of the hole. With it the engineer can have available the dimensions necessary for computing volume.

The method for determining whether the hole has cavities is to use a telltale in the mud, either a dye, easily identified chemical, or a solid having the approximate density of the mud. The time required for the telltale to make a trip down the drill-pipe and up the annulus gives some indication of the volume of the hole. It will not show the extent of large cavities, as the mud-stream follows the drill-pipe and has a diminishing effect as the distance from the drill-pipe increases. Nor will the telltale show the location of the cavities. A cavity 8 ft. in diameter would require 125–150 times as much cement slurry to fill it as the average annular space between a hole drilled to gauge and the casing. Only a few feet of cavity of such diameter is required to use up the cement allotted to the well. Equally as bad is the enlargement of the hole diameter of only a few inches extending over several hundred feet vertically. Both phenomena are more common than is generally believed. Causes of cavitation and their indications during drilling are discussed. Temperature surveys during cementing will indicate to what height the cement has risen. Besides these specific troubles due to caving, others more generally known are briefly reviewed. Such are those due to channelling and to trapping air under the plugs. Remedies are indicated.

A. H. N.

1158. Patents on Drilling. R. K. Hertel. U.S.P. 2,323,326, 6.7.43. Appl. 9.1.42. Latch mechanism for hooks.

J. Neufeld. U.S.P. 2,323,484, 6.7.43. Appl. 12.5.41. Well-logging method and apparatus using radioactivity.

L. L. Hardeman. U.S.P. 2,323,992, 13.7.43. Appl. 7.5.41. Well-shaft.

L. Horvitz and E. E. Rosaire. U.S.P. 2,324,085, 13.7.43. Appl. 21.12.39. Geochemical well logging during drilling.

R. M. Lilly. U.S.P. 2,324,096, 13.7.43. Appl. 5.6.41. Well hoisting device attached to the derrick V-door.

L. C. Miller and R. F. Bolton. U.S.P. 2,324,102, 13.7.43. Appl. 9.2.40. Means for directional drilling of wells.

L. C. Miller. U.S.P. 2,324,103, 13.7.43. Appl. 19.12.40. Well-survey apparatus protective housing.

A. L. Rodgers. U.S.P. 2,324,174, 13.7.43. Appl. 3.5.40. Weight indicator using a spring.

A. S. Foster. U.S.P. 2,324,379, 13.7.43. Appl. 4.9.40. Portable pipe vise.

R. De Long. U.S.P. 2,324,682, 20.7.43. Appl. 26.3.41. Side-wall coring tool for wells.

M. L. Hart. U.S.P. 2,324,698, 20.7.43. Appl. 21.9.40. Well measuring device for ascertaining depths.

A. Sowders. U.S.P. 2,324,886, 20.7.43. Appl. 26.2.42. Well tool.

B. W. Sewell. U.S.P. 2,324,956, 20.7.43. Appl. 25.11.40. Borehole tool for slotting pipes in well.

C. C. Brown, J. R. Dodson, Jr., and F. L. Scott, Jr. U.S.P. 2,325,104, 27.7.43. Appl. 30.6.41. Outside pipe cutter for wells.

F. L. Haushalter and L. L. Horchitz. U.S.P. 2,325,132, 27.7.43. Appl. 28.10.41. Protector for drill-stem.

J. H. Schreiber. U.S.P. 2,325,429, 27.7.43. Appl. 16.7.41. Joint-breaker and cathead.

B. G. Goble. U.S.P. 2,325,503, 27.7.43. Appl. 2.1.41. Combination sand-pump and boiler.

R. L. Crum. U.S.P. 2,325,745, 3.8.43. Appl. 20.6.39. Rotary drilling-bit with toothed cutters.

I. Jacoel. U.S.P. 2,325,777, 3.8.43. Appl. 12.12.42. Tool for splicing cable and tightening strands therein.

C. F. Terrell, Jr. U.S.P. 2,325,811, 3.8.43. Appl. 2.10.41. Drilling-sleeve for rotary drilling-strings.

D. R. Moore. U.S.P. 2,326,052, 3.8.43. Appl. 13.4.42. Pipe-handling and racking platform for oil-well derricks.

J. T. Hayward. U.S.P. 2,326,219, 10.8.43. Appl. 30.12.39. Well depth recording in combination with drilling-string.

J. G. Richey. U.S.P. 2,326,394, 10.8.43. Appl. 22.11.39. Combined safety-joint and jar.

I. M. Spangler. U.S.P. 2,326,404, 10.8.43. Appl. 15.3.41. Setting-tool for bridging plug.

L. Spencer. U.S.P. 2,326,405, 10.8.43. Appl. 2.6.41. Side-wall sampling device for well bores.

F. A. Taylor and L. Spencer. U.S.P. 2,326,411, 10.8.43. Appl. 22.4.40. Setting-tool for cement retainers.

P. T. Bynum. U.S.P. 2,326,435, 10.8.43. Appl. 24.5.40. Coring apparatus.

J. U. Teague and G. E. Cannon. U.S.P. 2,326,577, 10.8.43. Appl. 1.1.43. Removal of mud cake in casing-cement jobs.

R. F. Davis. U.S.P. 2,326,640, 10.8.43. Appl. 29.1.41. Apparatus for determining the dip in the earth's substrata by electrical logging.

P. T. Bynum. U.S.P. 2,326,827, 17.8.43. Appl. 15.4.40. Coring apparatus for side-wall operations.

E. B. Williams, Jr. U.S.P. 2,326,908, 17.8.43. Appl. 29.5.42. Drill-bit.

H. S. Dauner. U.S.P. 2,327,023, 17.8.43. Appl. 23.12.41. Side-wall drilling and sampling tool.

B. H. Barnes and B. S. Minor. U.S.P. 2,327,088, 17.8.43. Appl. 9.3.42. Apparatus for installing protectors on drill-pipes.

J. W. Botkin. U.S.P. 2,327,092, 17.8.43. Appl. 21.4.41. Apparatus for cementing wells by the squeeze method.

J. D. MacKnight. U.S.P. 2,327,118, 17.8.43. Appl. 28.12.40. Submersible barge for use in oil-well producing operations in a body of water. A. H. N.

Production.

1159. Formulæ for Calculation of Sucker-Rod Loads. J. Zaba. *Oil Gas J.*, 12.8.43, **42** (14), 69.—Three formulæ are available for the calculation of well loads. These are

discussed. The first formula, suggested by J. C. Slonneger, is recommended by the American Petroleum Institute for calculations of peak loads for designing of surface pumping equipment. The formula is as follows:

$$P = (W_r + W_f)\left(1 + \frac{S \times S.p.m.}{5400}\right)$$

where P = peak polished-rod load (lb.); W_r = weight of rod-string, neglecting buoyancy; W_f = weight of fluid load = $0{\cdot}034D^2L$.; D = effective diameter of plunger (in.); L = depth of pump (ft.); S = polished-rod stroke (in.); and $S.p.m.$ = strokes/minute. The formula was evolved for average conditions, and is particularly useful because of its simplicity. It is entirely satisfactory for normal conditions and for slow speed of pumping. It has been reported, for instance, that the average peak polished-rod load calculated with this formula for 32 wells on the west side of the East Texas field was 10,115 lb., while the average actual load as determined by dynomometer was 7549 lb. At higher speed of operation the formula appears to give too low values for peak load, and a substantial safety factor would have to be used under such conditions. In comparing the A.P.I. formula with the Langer formula (given in this instalment), Dralle and Lamberger suggest that a safety factor of the order of 1·6 would be needed at high speeds for the A.P.I. formula. Other authors suggest the factor of 25%.

The second formula is that suggested by Kenneth N. Mills. It is based on two primary assumptions: (1) That the motion imparted to the well is simple harmonic. Although this is not strictly true, the error resulting from this assumption is not great so far as maximum acceleration is concerned. (2) That the acceleration of fluid contributes little to the peak well-load. This assumption is justified by the difference of the rate of transmission of stresses in sucker rods and in the fluid and by the comparatively high degree of compressibility of the fluid. The formula is as follows:

$$P = W_0 + W_r\left(1 + \frac{LN^2}{70{,}500}\right)$$

where P = peak polished-rod load (lb.); W_0 = weight of fluid (lb.); W_r = dry weight of rods (lb.); L = length of stroke (in.); and N = number of strokes/minute. The formula, like the A.P.I. formula, has the advantage of simplicity. It agrees fairly well with actual load measurements. In a group of wells tested the formula agreed with actual load measurement in 58% of cases with accuracy of from 90% to 100%, in 25% of cases with accuracy of from 80% to 90%, in 17% of cases with accuracy of from 0% to 80%. The formula is widely used.

The third formula is Langer's, recently developed from the results of over 200 carefully controlled tests on a single well. The formula is exhaustive in its treatment, and was therefore approximated into a simpler form for field work. The formula is:

$$P = W_r - W_{rb} + W_{0d} + 0{\cdot}75LN\ [17A_r\ Tan.(0{\cdot}0004DN)^\circ + A_0],$$

where P = peak polished-rod load (lb.); W_r = weight of rods in air (lb.); W_{rb} = weight of fluid displaced by full length of rod-string (lb.); W_{0d} = differential fluid load; L = length of polished-rod stroke (in.); N = number of strokes/min.; A_r = area of sucker rods (in.²); D = length of rod-string (ft.); and A_0 = net plunger area (in.²).

Results obtained from the use of this formula agreed quite closely with actual load measurements on the test-well previously mentioned. The main objections raised in discussion of this formula were that it was tested only in one well of a given depth.

A. H. N.

1160. Benefits of Slow Pumping Rates. N. Williams. *Oil Gas J.*, 19.8.43, **42** (15), 49.—Production practices in western Kansas until recent years were generally characterized by comparatively high rates of fluid withdrawals. Under those practices most wells were completed with large-sized tubing and pumps and heavy-duty pumping equipment with a view to handling large volumes of fluid. This was induced to a great extent by the procedure which then existed of basing allowables on physical potential tests, in which wells were pumped at capacity over 24-hr. periods. With the large-sized equipment operated at high speeds and long pumping strokes, greater

fluid capacity could be shown and, in turn, higher allowables obtained. This drew water in rapidly, accentuating natural encroachment, and as the rate of water intrusion increased, it followed that increasingly large volumes of fluid had to be lifted to maintain oil allowables. General adoption of the drawdown method of determining well productivity has been an important factor in retarding water encroachment. This method, involving calculations based on fluid levels at various low rates of production, eliminates occasion for pumping wells at capacity during tests, and so forestalls pulling a lot of water into the wells at those times. It also has made possible the use of much smaller pumping equipment, tubing, and pumps in completion of wells, which has been an incentive towards lifting smaller volumes of fluid during regular pumping operations. However, with water increases in wells, many operators continue to resort to relatively high rates of fluid withdrawals to recover the oil, with the result that the rate of water increase in turn mounts rapidly.

Production records of a lease in Kansas are given and studied in some detail. Estimates are made for potential production, and show an additional 131,300 brl. of oil produced at the low rates more than at the higher rates studied. The case of a well is detailed. In this case during the period the well was produced at the rate of approximately 15 brl. of fluid/hr., the oil recovery was at the rate of only 168 brl./1% increase in water production. When the withdrawal rate was reduced to approximately 9 brl. of fluid/hr., the recovery rate was increased to 938 brl. of oil/1% water increase. After the well had produced slightly over 20,000 brl. of oil, the withdrawal rate was increased to approximately 11 brl. of fluid/hr., resulting in a reduction in the oil-recovery rate to 388 brl./1% water increase. A. H. N.

1161. Design of Sucker-Rod Strings. J. Zaba. *Oil Gas J.*, 19.8.43, **42** (15), 60.—There are two general methods of designing a sucker-rod string. The first is to assign to each of the graduated sections of the string its maximum stress. In other words, a point in the string is determined at which the stress in the rod equals the arbitrarily selected maximum safe working stress, and from this point up a larger-size rod is used. The second method consists of designing the string in such a manner that the unit stresses are equal in the top rod of each of the different size sections of the string. The second method is safer, since it provides for a greater safety margin as far as corrosion pitting is concerned.

The first method gives :—

$$R_1 = \frac{Sa_1 - AWL\left(1 + \frac{b^2s}{g}\right)}{W_1\left(1 + \frac{b^2s}{g}\right)}$$

$$R_2 = \frac{Sa_2 - Sa_1}{W_2\left(1 + \frac{b^2s}{g}\right)}$$

$$R_3 = \frac{Sa_3 - Sa_2}{W_3\left(1 + \frac{b^2s}{g}\right)}$$

where R_1, R_2, and R_3 = lengths of bottom, second, and third sections of rods respectively (ft.); S = permissible unit stress in rods (lb./sq. in.); a_1, a_2, and a_3 = areas of bottom, second, and third sections respectively (sq. in.); A = area of plunger (sq. in.); W = hydrostatic pressure exerted by 1 ft. of fluid = 0·43 lb./sq. in. for water; W_1, W_2, and W_3 = weight/ft. of bottom, second, and third sections; b = angular velocity (radians/sec.); s = one-half the polished-rod strokes (ft.); and L = setting depth of pump (ft.).

The second method gives

$$\frac{W_f + W_1(L - R_2)}{a_1} = \frac{W_f + W_1(L - R_2) + W_3R_3}{a_3}$$

where $W = AWL$.

In this case R_3 is calculated and R_1 is found by difference.

Since the fatigue of rods is affected both by peak load and range of loadings,

attempts have been made, particularly in case of heavy wells, to level out the normal peak loads imposed on sucker rods by normal operations and the shock loads resulting from any one of many possible causes. Several devices designed to accomplish this purpose are commercially produced and successfully used. The basic principle is to eliminate the rigid connection between rod-string and beam by arranging for an elastic, compressible link between polished rod and the beam. This can be accomplished in several ways. For instance, a rubber-cushion device is set between the carrier bar of the beam hanger and the polished-rod clamp. When any load is picked up suddenly, the rubber is compressed, causing the polished rod to lag behind the action of the beam, decreasing the impulse acceleration factor. The energy stores in the compressed rubber is then gradually released, causing the load to be spread over longer period. The device using compressed air as a cushioning medium consists of a cylinder attached to the beam with the rod-string connected to the rod of a piston which moves in the cylinder. Sufficient air pressure is maintained in the cylinder under the piston to support the piston at the top of the cylinder against the weight of rods. When the fluid load is picked up, the piston is drawn down part way, through the cylinder, thus decelerating the speed of polished rod in relation to the beam. When the peak load is passed, the compressed air pushes the piston to the top of cylinder, increasing the load. The result is more even distribution of loads, and therefore the reduction of peak loads. A. H. N.

1162.* Individual Acid Treatment for Thin Multiple Zones. F. B. Taylor. *Oil Wkly*, 23.8.43, **110** (12), 18.—Separated multiple zones of saturation in Dayton Pool, Phillips County, North-west Kansas, has forced the development of a new acid-treating procedure. Production in the field is from Lansing–Kansas City lime (Pennsylvanian) with saturation in from 1 to 10 benches irregularly distributed through 300 ft. of formation. The productive benches are generally between 1 and 9 ft. in thickness.

Completion practice is to cement 5½ in. on top of the bottom break. Before setting pipe it is customary to make an electrical log of the hole, and to use this with sample analyses to determine casing spot and zones of the formation to be acid treated. The first part of the treatment of the formation is normal, with the acid being run in through the casing. This stage takes care of the bottom break of the formation which remains open below the casing spot. On a typical well the next step is to set a removable bridging plug in the casing above the top of the lower break which has just been treated. The next higher break is then opened by ripping the casing, and this break is then treated down the casing in a conventional manner. This process is continued up the hole until each saturated bench indicated as a prospective pay section is treated. Each treatment is individual by backing the removable plug up the hole and opening the casing in the next zone to be isolated. Treatment has also been made through tubing, as in one instance where the casing was ripped in three spots and two packers were run in on the tubing string. The packers were set between the casing areas ripped open, and the lower break was then treated. Following this, the tubing was raised and the second break treated; the third break was then treated, after the tubing had been raised through the position of the upper packer. In this last-described series the treatments were made through the tubing in three separate injections.

As is usual practice, the acid is run into the hole under an oil load, surface pressure being from 500 to 800 lb., as required. Acid volumes vary according to the thickness of the sections to be treated, but in most instances are between 250 and 1000 gal./section. A. H. N.

1163. Plunger Travel of Pumps. J. Zaba. *Oil Gas J.*, 26.8.43, **42** (16), 66.—With sucker rods considered a long elastic system, with one end fixed and the other vibrating with 1° of freedom, the plunger stroke becomes the amplitude of a forced vibration resulting from the effect of: (1) the disturbing force (the force available for moving the plunger), (2) the frequency of natural vibrations of rods, and (3) the damping forces present in the system. The motion of the plunger is out of phase with, and lagging behind, the motion of the polished rod.

The normally expected and calculated length of plunger travel under given set of pumping conditions (speed of pumping, length of stroke, size of plunger and rods, and depth of operation of the pump) can still be altered to a considerable extent by

a number of other factors. Among these factors changes in pump friction and handling of free gas may bring about considerable changes in the length of plunger travel. The matter of pump friction is difficult to determine. While the coefficient of friction of different cup materials against the different metals of working barrel are known, the degree of lubrication present is an unknown factor. Furthermore, the abrasive matter, frequently handled by the pump, may increase the coefficient of friction above the value for perfectly dry surfaces. In case of cup pumps the frictional load depends on the depth of operations of the pump, since the load is a function of the coefficients of friction and of the pressure by changing the loads handled by the plunger.

Three formulæ are given for calculating plunger travel from polished-rod travel. These are Coberley's, Rieniet's, and Langer's formulæ. The last formula, when simplified for field work, is :—

$$E.S.P. = \frac{S}{\cos(0{\cdot}0004LN)^\circ} - \frac{W_{OD}L}{2(10)^6}\left(\frac{1}{A_R} + \frac{1}{A_T}\right)$$

where $E.S.P.$ = effective plunger stroke (in.); S = polished-rod stroke (in.); W_{OD} = differential fluid load (weight of net fluid head on full area of plunger) (lb.); L = length of rod-string (ft.); A_R = cross-sectional area of rod (sq. in.); A_T = cross-sectional area of tubing (sq. in.), and N = number strokes per minute. A. H. N.

1164. High-Pressure Corrosion Controlled by Chemicals. H. F. Simons. *Oil Gas J.*, 2.9.43, **42** (17), 29.—An unusual type of corrosion is being experienced in some of the wells at Opelika, a high-pressure distillate pool in Henderson County, Texas. The corrosion is severe, and occurs in the christmas-trees and surface connections to a point just beyond the line-valve. Corrective measures have been inaugurated while the fundamental causes are being sought. The corrosion is being controlled by the injection of chemicals into the wells.

Despite the absence of identifiable corrosive compounds, the appearance of the corroded parts and their location leads to the belief that it is due to direct chemical attack aggravated or concentrated by physical conditions. It may be due to instantaneous but continuous formation of water containing corrosive elements at the points affected. After the internal surface has been destroyed the moisture is more readily retained and the corrosion speeds up. What part turbulence, stream-velocity changes, and pressure drops in the christmas-tree play is difficult to determine. The latter, while appreciable, would not be great, the drop from tubing hanger to beyond the line valve not being much over 50 lb./sq. in. at maximum flow-rates. Preventive measures consist at present of injecting chemical into the wells so that it travels down the annular space and back through the tubing. The chemical mixture used consists of soda ash containing sodium hexametaphosphate as its principal ingredient and a commercial inhibitor commonly used for protection of steel equipment. The soda ash, being strongly basic, corrects the *p*H value; the object of the hexametaphosphate is to prevent precipitation of calcium carbonate at the formation, and the inhibitor counteracts, or at least reduces, the action of acids or acidic waters on the steel. The amount of soda ash to use was determined quantitatively so as to raise the *p*H of the produced water to 6–6·5 range. The chemical solution is prepared at the plant with all ingredients being carefully weighed to ensure that proper concentrations are obtained. The completed solution of proper concentration is then hauled by tank-truck to the individual wells, where the required amounts of solution are delivered to storage tanks. The injection pumps take suction directly from these tanks. Details are given for quantities, etc.

The present treatment is producing results, and the regular inspection indicates that the corrosion is materially reduced. Inspection periods have been 30 days, but are being increased to 60 days. There may still be precipitation of calcium carbonate at the formation due to the introduction of the soda ash, but the acid treatment previously tried can be used to remove this deposition if it becomes troublesome. Complete solution of the problem will depend on the establishment of the corrosion cycle, and the reason why the corrosive influences are present only in the well-head connections, and not throughout the entire tubing strings and gathering system. This will require extensive work with control measures being used until a positive cure is developed. A. H. N.

1165. Plunger Travel from Cards. J. Zaba. *Oil Gas J.*, 2.9.43, **42** (17), 43–44.—Slonneger's graphical method of analyzing a dynamo-meter card is given. This may be summarized as follows: Given the motion of one end of a sucker-rod system, that is the motion of the polishing rod, and the instantaneous loadings, and what follows instantaneous stretch of the rods, at different points of the polished-rod motion, the motion of the other end of the rods—that is, the plunger stroke—can be quite accurately determined. Graphic solution is particularly adapted for this method, since with given curve of the polished-rod motion the stretch of rods has only to be added or subtracted in order to arrive at the curve of the relative plunger motion. To accomplish this the dynamometer card is placed in such a way that the loads are read horizontally and the polished-rod positions vertically, with up-stroke upwards. To the right of the card a semi-circle is drawn with diameter equal to the polished-rod stroke and to the same scale as the dynamometer card. For all practical purposes projection of any point of the card on the semi-circle represents corresponding position of the crank. From the semi-circle the polished-rod motion curve is plotted with crank positions as abscissæ and polished-rod positions as oridnates. To be able to determine graphically the stretch of rods for any desired point of the polished-rod motion curve, the rod-stretch line is laid out. The static weight of sucker-rods is taken as zero stretch. The stretch of rods due to their own weight is laid out, below the base line (negative stretch), on the zero line of the card. This stretch may be obtained from the formula:

$$e_r = \frac{L_2}{1{,}320{,}000}$$

where e_r = stretch of rods due to their own weight (in.), and L = length of sucker rods (ft.). The stretch for dynamic loading is calculated from

$$e_d = \frac{PL^2}{1{,}000{,}000\ W_r}$$

where e_d = stretch due to dynamic loading (in.); P = dynamic load (lb.); L = length of rod (ft.); and W_r = weight of rods.

An approximate method due to Kemler is also described with method of determining under- and over-travels. A. H. N.

1166. Patents on Production. A. Moeller, H. Tochtermann, and O. Trösken. U.S.P. 2,323,344, 6.7.43. Appl. 17.9.40.—Process of breaking petroleum emulsions and breaking agent.

E. D. Mattocks. U.S.P. 2,323,556, 6.7.43. Appl. 29.11.40. Method and apparatus for determining effective porosity.

J. E. Harmon. U.S.P. 2,323,713, 6.7.43. Appl. 14.7.41. Method of making screens in tubular forms.

J. D. Nixon. U.S.P. 2,323,838, 6.7.43. Appl. 1.4.40. Fluid-flow device for pressure regulation.

J. D. Nixon. U.S.P. 2,323,839, 6.7.43. Appl. 27.1.41. Fluid-flow-control device with pressure regulation.

A Boynton. U.S.P. 2,323,893, 13.7.43. Appl. 8.12.39. Stage-lift flow device using side valves.

R. E. Fulkerson. U.S.P. 2,323,989, 13.7.43. Appl. 4.11.40. Control-head packer for wells.

W. Brauer. U.S.P. 2,324,132, 13.7.43. Appl. 10.2.41. Automatic intermitting unit for a pressure fluid-lifting apparatus.

G. L. Parkhurst. U.S.P. 2,324,172, 13.7.43. Appl. 31.10.40. Processing well-fluids for effecting maximum recovery from a high-pressure petroleum reservoir.

T. A. Bertness, N. Johnston, and D. O. Newton. U.S.P. 2,324,254, 13.7.43. Appl. 11.3.41. Method of removing mud-barriers from oil-wells.

C. P. Walker and E. E. Simmons. U.S.P. 2,324,340, 13.7.43. Appl. 8.2.41. Detector for pressure wave translation systems.

W. Brauer. U.S.P. 2,324,355, 13.7.43. Appl. 2.6.41. Dual automatic intermitting unit for fluid-lifting apparatus disposed in wells.

M. De Groote and B. Keiser. U.S.P. 2,324,488, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,489, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,490, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,491, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,492, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,493, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,324,494, 20.7.43. Appl. 7.7.41. Process for breaking petroleum emulsions.

R. B. Fraser. U.S.P. 2,324,689, 20.7.43. Appl. 19.12.40. Valve for oil-well swabs.

H. C. Beene, H. Marks, and D. L. Mitchell. U.S.P. 2,324,814, 20.7.43. Appl. 3.9.40. Test device for oil-wells.

V. J. Beissinger. U.S.P. 2,325,218, 27.7.43. Appl. 11.8.41. Process for the gravel packing of wells.

R. G. Taylor, Jr., and D. B. Hooser. U.S.P. 2,325,556, 27.7.43. Appl. 22.3.41. Well-swab for use on a pipe in a casing.

R. L. Chenault. U.S.P. 2,325,661, 3.8.43. Appl. 10.12.42. Filter for inverted deep-well pump.

J. McAffee. U.S.P. 2,325,695, 3.8.43. Appl. 22.8.41. Fluid-meter.

E. F. Stover. U.S.P. 2,325,714, 3.8.43. Appl. 1.11.41. Flow-meter.

C. F. Schorn. U.S.P. 2,325,884, 3.8.43. Appl. 21.3.42. Flow-meter.

A. J. Zschokke. U.S.P. 2,326,114, 10.8.43. Appl. 8.12.41. Gun perforator.

E. W. Rearwin. U.S.P. 2,326,170, 10.8.43. Appl. 30.11.40. Well-pumping apparatus of the double-acting piston type.

L. L. McConnohie. U.S.P. 2,326,378, 10.8.43. Appl. 8.1.40. Submerged double-acting pump.

W. M. Mount. U.S.P. 2,326,384, 10.8.43. Appl. 14.10.41. Demulsifying and settling tank.

L. Spencer. U.S.P. 2,326,406, 10.8.43. Appl. 18.8.42. Gun perforator.

H. P. de Wit. U.S.P. 2,326,442, 10.8.43. Appl. 5.8.41. Gas-lift control for intermittent operation.

B. J. Festervan and N. F. Henderson. U.S.P. 2,326,528, 10.8.43. Appl. 11.6.40. Paraffin scraper.

B. L. Opsal. U.S.P. 2,326,556, 10.8.43. Appl. 22.8.40. Device for spooling Reda and like cable to pull tubings from wells.

G. Allen. U.S.P. 2,326,599, 10.8.43. Appl. 27.5.42. Process for breaking petroleum emulsions.

G. Allen. U.S.P. 2,326,602, 10.8.43. Appl. 27.5.42. Process for breaking petroleum emulsions.

A. L. Grisé. U.S.P. 2,326,637, 10.8.43. Appl. 14.11.42. Calibration means for piston meters.

J. C. Myers. U.S.P. 2,326,668, 10.8.43. Appl. 25.8.41. Device for controlling the transmission of power to pumps.

H. D. Kinney. U.S.P. 2,326,867, 17.8.43. Appl. 29.1.40. Valve structure for combined formation testing tools and pressure recorders.

H. Dew Thomas. U.S.P. 2,326,902, 17.8.43. Appl. 26.11.41. Pump.

P. H. Granger. U.S.P. 2,326,940, 17.8.43. Appl. 15.3.41. Oil-well tool in combination with well casing and tubing.

L. C. Chamberlain. U.S.P. 2,327,017, 17.8.43. Appl. 15.3.37. Treatment of wells producing mineral fluids.

O. W. Lyons and J. H. Adkinson. U.S.P. 2,327,051, 17.8.43. Appl. 27.7.40. Apparatus for treating wells with streams of fluid issuing from nozzles.

J. H. Wiggins. U.S.P. 2,327,083, 17.8.43. Appl. 2.1.41. Side-wall seal for floating tank roofs.

J. H. Wiggins. U.S.P. 2,327,084, 17.8.43. Appl. 15.3.41. Breather-type storage apparatus for gases and volatile liquids.

J. H. Wiggins. U.S.P. 2,327,085, 17.8.43. Appl. 27.1.42. Breather-type tank.

G. O. Kimmell. U.S.P. 2,327,111, 17.8.43. Appl. 27.7.40. Apparatus for removing samples from flowing streams such as exist in high-pressure oil or gas-well tubings.

L. Spencer. U.S.P. 2,327,141, 17.8.43. Appl. 23.9.42. Gun perforator.

A. H. N.

Gas.

1167.* **Natural-Gas Pipe-Line Dehydration.** H. N. Wade. *Pet. Engr*, March 1943, **14** (6), 184, April 1943, **14** (7), 100.—The articles bring up to date information given in a previous article by the writer (*Gas*, May 1940) on the same subject. Dehydration plants are divided into two general classifications: (*a*) those using a continuous circulation of a hygroscopic liquid for removing water from the gas, (*b*) those using solid moisture adsorbent materials, usually in granular form. General descriptions and flow-sheets of the two systems are provided. Operating reports recently collected are summarized and available cost data given. The largest plant still using calcium chloride solution went into operation in December 1937, treating gas at 500 lb./sq. in. on the outlet of an absorption plant and sulphur-removal unit using the soda-ash process. It processes 73 M. cu. ft. a day of gas containing a trace of H_2S (normally less than 0·5 grain per 100 cu. ft.), but no oxygen. Operation and maintenance costs at 21·8 c. per M. cu. ft. were stated to be increased by mechanical troubles and deterioration of solution in the dehydration unit apparently caused by accidental carry-over of soda-ash solution from sulphur-removal unit. Average dew-point depression accomplished is 20° F., giving adequate protection against hydrate formation except under temporary and unusual weather conditions. Of four plants using diethylene glycol solution consumptions of glycol in lb. per M. cu. ft. are:—

(1) Operating at 400-lb. pressure — 0·22.
(2) Slightly lower pressure — 0·501.
(3) At 300-lb. and gas temperature over 90° F. under heavy load — 0·811.
(4) At 500-lb. — 0·25.

Costs, including operation, maintenance, glycol make-up, and prorated fuel for the first two plants mentioned, are about 32 c. per M. cu. ft. Satisfactory operation of a combination dehydration and H_2S-removal plant, using a mixture monoethanolamine and diethylene glycol under Girdler patents, is mentioned. Experience shows that solution circulating pumps should be of the plunger type, not the packed-piston type. One operator reports the desirability of installing filters to keep the solution free of foreign matter. Three operators report no corrosion troubles, but the fourth experienced corrosion of the seamless steel tubes in the solution heat-exchanger and of admiralty bronze tubes in the still reboiler, both of which failed. The gas contained small amounts of mercaptans, but no detectable H_2S. The still base temperature was 320° F. and still pressure 10 lb. Overhead vapours from the still showed a positive test for presence of H_2S, and the product of corrosion from the heat exchanger consisted of ferrous oxide and iron sulphide. It was concluded that decomposition of mercaptans was responsible. Lowering the still temperature to 280° F. and pres-

sure to 3 lb. resulted in production of a clear glycol solution and no detectable H_2S in the overhead still vapours.

Information available to the writer on solid-adsorbent-type plants is of only a general character, but indicates that the two forms of activated alumina now available for this purpose offer the most satisfactory performance that has been obtained by solid absorbents. Such systems are capable of a much greater degree of drying than possible with the hygroscopic liquid-type plants.

Five graphs presented with the articles provide the basic information required for the rough design of hygroscopic-solution-type plants, based on actual operating experience. References to similar data bearing on solid adsorbent plant and other appropriate literature references are provided. R. A. E.

Cracking.

1168. Patents on Cracking. H. Dreyfus. E.P. 554,831, 21.7.43. Appl. 18.12.41. A method of cracking hydrocarbons is described in which the hydrocarbons are passed down a cracking chamber in the form of a self-supporting helical stream. The hydrocarbon may be sprayed or atomized into the chamber by means of nozzles or jets arranged tangentially near the top of the wall of a cylindrical cracking chamber so that the spray or mist of hydrocarbon oil and the vapour arising from its volatilization adopts a helical path as it travels down the cracking chamber.

The Distillers Co., Ltd. E.P. 555,588, 30.8.43. Appl. 27.2.42. Process for the removal by selective oxidation of acetylene, together with any co-present hydrogen, from a gaseous mixture containing it in admixture with another hydrocarbon, or hydrocarbons, with or without hydrogen. The gaseous mixture is passed over an agent consisting of copper oxide maintained at a temperature between 275° and 450° C.

J. H. Hirsch. U.S.P. 2,316,334, 13.4.43. Appl. 25.3.41. In a conversion process of hydrocarbons, vapours evolved in a coking operation are subjected to dephlegmation with crude-oil residual stock. Dephlegmated vapours are fractionated to form a reflux condensate, which is then passed to a heating coil and heated to cracking temperature. The resultant mixture of reflux condensate and unvaporized residual stock are passed to a flash dephlegmatizing zone, where the mixture is stripped. The stripped mixture is combined with heated products from the heating coil, and the admixed products are coked. Vapours evolved from the coking zone are passed to the dephlegmatizing zone, and vapours from the flash dephlegmatizing zone are fractionated to form a reflux condensate. This is directed to a cracking zone, and the resultant cracked products are separated into vapours and liquid residue. Separated vapours are passed to the dephlegmatizing zone. The liquid residue is flashed and also passed to the dephlegmatizing zone.

D. G. Brandt. U.S.P. 2,316,931, 20.4.43. Appl. 14.5.40. A continuous process is described for converting corrosive petroleum oils by the use of lime in which the direct heating of the lime with the oil by firing is avoided. H. B. M.

Hydrogenation.

1169. Patents on Hydrogenation. Shell Development Co. E.P. 553,705, 2.6.43. Appl. 12.9.41. A process is described for the catalytic conversion of organic materials in the vapour phase at high temperatures in the presence of ferrous metals. It has special reference to the treatment of hydrocarbon vapours with dehydrogenation catalysts, particularly those comprising an oxide of chromium, molybdenum, tungsten, vanadium, or manganese, which are normally substantially free from iron and are subject to poisoning by iron. Contamination of the catalyst by iron is eliminated by maintaining in the feed to the conversion zone 0·0006–0·015% by weight of sulphur in the form of elemental sulphur or in the form of a reducible sulphur compound.

W. J. Mattox. U.S.P. 2,316,271, 13.4.43. Appl. 12.8.40. In a process for the dehydrogenation of hydrocarbons having 6–12 carbon atoms to the molecule, vapours of the hydrocarbons are combined with hydrogen and the mixture is subjected to contact with a metal oxide dehydrogenating catalyst under the following conditions:

Temperature, 450–650° C.; liquid hourly space velocity, 0·1–20 volumes per volume of catalyst; and mass velocity, at least 5 milligrams per square centimeter per second.
H. B. M.

Polymerization and Alkylation.

1170. Patents on Polymerisation and Alkylation. Standard Oil Development Co. E.P. 553,334, 18.5.43. Appl. 10.7.40. An adaptation is described of the two-stage alkylation process in which a mixture containing the mono-olefins to be reacted is first contacted with sulphuric acid and the extract of mono-olefins so formed is reacted with *iso*paraffins to produce the desired product. The sulphuric acid and the mixture containing mono-olefins are fed to the extraction zone in the ratio of between 0·4 and 1·25 mols. of acid per mol. of mono-olefins, and the resultant extract is used for the alkylation.

Shell Development Co. E.P. 553,749, 3.6.43. Appl. 1.12.41. In a process for the production of hydrocarbons by reacting an alkylatable hydrocarbon with an alkylating agent in the presence of an organic sulphur acid catalyst, at least one of the reactants is treated with a substantially hydrocarbon insoluble strong carboxylic acid prior to contact with the catalyst. The effective life of the alkylation catalyst is thus increased.

Texaco Development Corp. E.P. 554,096, 21.6.43. Appl. 2.7.41. In a process for effecting conversion of hydrocarbons—*i.e.*, isomerization, alkylation, polymerization, and cracking—a special type of catalyst is used. It is a mixed halide having the approximate empirical formula $MeH_x^1H_y^2$, where *Me* signifies a polyvalent metal selected from Groups 2, 3, 4, 5, 6, and 8 of the Periodic Table; H^1 and H^2 are different halogen atoms and x and y have values sufficient to satisfy the valency of the metal.

A. L. Mond. E.P. 554,240, 25.6.43. Appl. 24.12.41. Process for synthesizing hydrocarbons which comprises reacting an *iso*paraffin with an olefin under alkylating conditions and in the presence of an alkylating catalyst in the liquid phase. The active ingredient of the catalyst is essentially hydrogen fluoride.

Shell Development Co. E.P. 554,825, 21.7.43. Appl. 8.9.41. Production of an alkylated hydrocarbon or an alkylated halogenated hydrocarbon from a saturated hydrocarbon or a halogenation product thereof which has a hydrogen atom attached to a tertiary carbon atom. The tertiary atom-containing compound is reacted with an organic halide having a halogenated aliphatic carbon atom, in the presence of a free acid alkylation catalyst. The process is applicable to the manufacture of other branched-chain products from *iso*butane, *iso*pentane, 2-methyl-pentane, 2 : 3-dimethyl-butane, 2 : 2 : 5-trimethylhexane, 3-ethyl-pentane, *cyclo*hexane, and the like.

Shell Development Co. E.P. 556,099, 20.9.43. Appl. 20.5.42. In the isomerization of saturated hydrocarbons the vapours, together with a hydrogen halide promotor, are passed through one of a number of isomerization zones containing a supported catalyst of the Friedel–Crafts type. A decreasing gradient of hydrogen halide promotor concentration is maintained in the isomerization zone or zones, and an increasing gradient of space velocity in the direction of flow. This is achieved by introducing additional portions of the hydrocarbon to be isomerized into the stream of the reaction mixture at a number of points along its length.
H. B. M.

Refining and Refinery Plant.

1171. Thermal Efficiency in Topping Plants. W. L. Nelson. *Oil Gas J.*, 28.1.43, **41** (38), 180.—The thermal efficiency of a topping plant is dependent mainly on the temperature attained in the exchangers, the temperature at which flue gases enter the stack, and the per cent excess air used at the still burners.

These three variables have been related by means of an efficiency equation and by equations showing amount of heat required per hour.

An example of a heat efficiency equation for a 10,000-brl. plant operating on Midcontinent crude is given and the heat required in B.Th.U./hour is shown.

In deriving an equation to calculate the heat required to operate a simple topping plant, the stack loss from the pipe-still is of particular importance. This item is a

function of the slack temperature and per cent excess air used in burning the fuel, and an equation relating these factors is given.

These equations serve as a useful guide in keeping a periodic check on operation.

D. L. S.

1172. Operating Multidraw Fractionating Towers. W. L. Nelson. *Oil Gas J.*, 1.4.43, **41** (47), 31.—Although multidraw fractionating towers are common equipment in petroleum refineries, there is some confusion among plant operators regarding their method of operation. Batch-distillation and flash-vaporization curves of a typical Midcontinent crude oil are presented and used in conjunction with a diagram of a tower with steam strippers to illustrate seven rules or principles of operation which are listed and discussed. These are :—

(1) Only the amount vaporized can be withdrawn above feed-plate. In raising the feed-plate temperature to increase vaporization, care must be taken not to overload the tower.

(2) Top temperature regulates the amount of gasoline. It does not directly regulate the degree of fractionation, which is dependent on the number of trays between the top and kerosine draw-plate.

(3) Opening the side-draw valve increases the yield of that product. The increase is due mainly to increase in E.P. and, to a minor extent, inclusion of some low-boiling material. At the same time it is necessary to close other side-draw valve(s) by a nearly corresponding amount (see Rule (1)).

(4) Closing side-draw valve decreases product.

(5) Changing top temperatures alters (3) and (4). This may be used, for example, in adjusting gravity or flash-point of the kerosine removed when the kerosine side-draw valve setting is altered. Kerosine yield will be increased or decreased according to whether the temperature is lowered or raised.

(6) The number of trays between products regulates fractionation. Thus withdrawing a given product from another tray without changing setting of side-draw valve will affect F.B.Pt. without materially altering the yield of product. Should the I.B.Pt. be also lowered, partial correction can be obtained by the use of additional steam in the stripper.

(7) Steam regulates the I.B.Pt. Attempts to use large amounts of steam for increasing the boiling range of a side-draw product are not usually successful. The proper method is to open the control valve and close by a like amount the control valve of a lower side-draw.

In connection with these rules, it is emphasized that the nature of the crude processed has an overriding effect on the composition of products, that change in the manner of withdrawing a product will result in changes in products withdrawn lower in the tower which will not be completely reflected in less than several hours.

Finally, it is stressed that high-boiling products are not necessarily withdrawn at low trays in the tower and, conversely, low-boiling products may be withdrawn low in the tower. The effects of changes in the point of withdrawal on the degree of fractionation of the various products are discussed. R. A. E.

1173.* The Solvent Extraction of Lubricating Oils. H. ter Meulen. *J. Inst. Petrol.*, September 1943, **29** (237), 237–252.—It is explained that the solvent extraction of lubricating oils is much more complicated than the study of kerosine extraction, and that the simple triangular representation is not sufficient to explain the phenomena fully. Approximate compositions of various oils are examined as a preliminary study of their solvent extraction. Experiments are reported and their results discussed. The influence of light/heavy selectivity of solvents is fully explained. This characteristic property of all solvents is the reason for the impossibility of extracting S.R. residues immediately with a single solvent to a suitable raffinate. The residues represent the ultimate case of a very wide cut, as the heaviest components, such as asphalt and resins, are present. A single solvent does not have such a low light/heavy selectivity that all asphalt is removed from the raffinate into the extract layer. Therefore single-solvent extraction processes are applicable only to distillate fractions. The only process capable of processing a S.R. residue is the Duo-Sol process, using a

mixture of phenol-cresols as the aromatic solvent and propane as the paraffinic solvent. These two solvents are only slightly miscible, and produce two layers. The solubility of asphaltenes in propane is practically negligible, and therefore all the asphaltenes are precipitated from the raffinate layer into the extract layer. The conclusion may be drawn that it would also be possible to remove the asphaltenes from a S.R. residue by propane precipitation and then solvent extracting the remaining asphalt-free lubricating oil with a single solvent. This was carefully investigated, but it appeared that besides the asphaltenes other very heavy components were present (resins) which could not be extracted. These resins were not precipitated sufficiently by propane alone, but the combination propane-phenol removed all the heavy components into the extract (phenol layer). The paper is followed by a discussion. A. H. N.

1174. Patents on Refining and Refinery Plant. Standard Oil Development Co. E.P. 553,100, 7.5.43. Appl. 3.11.41. In a process for desulphurizing, stabilizing, and fractionating a hydrocarbon distillate, the original material is introduced into the top of a plate-tower, the bottom of which is maintained at a temperature sufficient to vaporize the most volatile hydrocarbon constituents and to boil out the hydrogen sulphide. Vaporized constituents and hydrogen sulphide are removed from the top of the tower, and the liquid is withdrawn from the bottom and passed into a second plate-tower, the bottom of which is maintained at a substantially higher temperature than that obtaining in the first tower. A substantial portion of the liquid is thus vaporized. Vapours are removed and cooled to condense at least a portion of them. The liquid is removed from the bottom of the tower, and condensed vapours and liquid are passed in indirect heat-exchange relationship with the hot liquid from the first tower. Finally, the condensate and liquid from the second tower are cooled. The process has particular reference to cracked naphtha, which may contain relatively large quantities of hydrogen sulphide and small amounts of light hydrocarbons which are too volatile for the purpose for which the naphtha is to be used.

L. M. Henderson and G. W. Ayers. U.S.P. 2,315,054, 20.4.43. Appl. 6.4.40. During the process of removing mercaptans from petroleum oils the latter are contacted with an aqueous alkali metal hydroxide reagent containing reaction products prepared in the following way. Light petroleum distillates containing organic acidic constituents, including naphthenic acids, phenols, and thiophenols, are contacted with an aqueous sodium hydroxide solution under suitable conditions to react sodium hydroxide with organic acidic constituents. Afterwards the aqueous sodium hydroxide solution is steam-stripped of hydrolyzable constituents and the stripped solution is concentrated to approximately 15% of reaction products.

W. T. Hancock. U.S.P. 2,316,954, 20.4.43. Appl. 9.6.39. During a refining process, petroleum hydrocarbons are heated, passed through a body of adsorptive material, and impregnated with a salt of the group consisting of zinc chloride and aluminium chloride. The adsorptive material is re-charged with the salt while the material is in the treating zone, by discontinuing the flow of hydrocarbons through the zone. A quantity of the salt is vaporized in a heating zone and the vapours are passed into the material. The vapours are condensed directly on the surface and within the pores of the material to promote uniformity of salt condensation throughout the body. Afterwards the hydrocarbons are again passed through the material.

W. L. Benedict. U.S.P. 2,317,600, 27.4.43. Appl. 30.3.40. Low-boiling petroleum distillates containing mercaptans are sweetened by electrolyzing a solution of an alkali-metal carbonate to form an alkali-metal hydroxide solution and an alkali-metal bicarbonate solution, and treating the distillate with the hydroxide solution. In this way mercaptans are transferred from the petroleum distillate to the hydroxide solution. The treated distillate is separated from the hydroxide solution and recovered as a product of the process. The mercaptan-containing solution is mixed with the bicarbonate solution to liberate mercaptans and form alkali-metal carbonate solution. The mercaptans are removed and the alkali-metal carbonate solution is passed back to the electrolyzing stage of the process.

F. A. L. Holloway and D. O. Wilkes. U.S.P. 2,317,770, 27.4.43. Appl. 12.7.41. To remove mercaptans from petroleum oils, they are introduced into one end of an absorption zone. A substantially sulphur-free solvent is passed into the other end

and a partly regenerated solvent is introduced into the zone at an intermediate point. The feed-oil is countercurrently contacted with the solvent and then removed from the treating zone. Spent solvent is removed from the other end of the zone and regenerated in a regeneration zone in such a way that a portion of regenerated steam from an intermediate part of the zone is removed. This stream is recycled to an intermediate point of the absorption zone. A substantially sulphur-free solvent is removed from the regeneration zone and recycled to the absorption zone. H. B. M.

Fire Prevention.

1175. Fires Caused by Bacteria. Anon. *Oil Gas J.*, 10.6.43, **42** (5), 40.—A communication received in connection with an article on "Methods of Combating Fires in Oil-storage Tanks" (*J. Inst. Pet.*, 1943, Abs. 580) directs attention to the rôle played by anaerobic bacteria. *Spirillum desulfuricans* belongs to this genus, and is capable of reducing sulphates to H_2S, and requires the following conditions :—

(1) Water with total absence of air (oxygen).
(2) Total absence of light.
(3) Presence of assimilable organic compounds.
(4) Presence of sulphate(s).

As the sulphate-reducing spirilla are present in practically every soil, their introduction into a tank is more or less a certainty. The first three conditions for existence of the bacteria are satisfied in most tanks, since any oxygen in solution in the water on entering the tank is quickly absorbed by the steel shell and by aerobic bacteria in the water and sludge. Where the fourth condition is also satisfied, bacterial action may be expected. In crude-oil tanks, for example, since oil-well waters invariably contain sulphates, conditions for existence of the bacteria are assured. Laboratory experiments have shown that in the corrosion of iron through the medium of sulphate-reducing bacteria, the ratio of total corroded iron to iron in the iron sulphide varies from 2·4/1 to 3·4/1. A suggested mechanism indicates a theoretical ratio of 4/1, and the difference ascribed to increase in hydrogen sulphide formation due to the necessity for oxidizing the hydrogen from the organic foods as well as the cathodic hydrogen. The formation of pyrophoric iron sulphide and the incidence of excessive corrosion appear to be preventable by ensuring conditions unfavourable to the existence of anaerobic bacteria—for example, changing the water in tank bottoms once a fortnight. This was found sufficient in the U.S. Navy for fire-lines on warships with which trouble was experienced on account of excessive corrosion.
R. A. E.

Chemistry and Physics of Hydrocarbons.

1176. A Spectrophotometric Method for the Analysis of Multi-Component Mixtures and Its Infra-Red Application. R. R. Brattain, R. S. Rasmussen, and A. M. Cravath. *J. appl. Phys.*, August 1943, **14** (8), 418–428. For monochromatic radiation the optical density of a mixture equals the sum of the optical densities of the components, or

$$D = d_1 + d_2 + \ldots + d_n \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and the optical density d_n of an individual component can be expressed by

$$d_n = \epsilon_n x_n \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This is the familiar Beer's law, where x_n is the mole fraction and ϵ_n the extinction coefficient (of the nth component) which is a constant for all values of x_n but varies with wave-length. Substitution of Eq. (2) in Eq. (1) gives for the optical density of D of a mixture at one wave-length.

$$D = \epsilon_1 x_1 + \epsilon_2 x_2 + \ldots + \epsilon_n x_n \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If the experimental conditions under which optical density is measured are such that both the above conditions hold, a mixture can be analyzed by the following steps: (1) Determination of the ϵ_n values of each pure component at n different wave-lengths. (2) Measurement of the optical densities of the mixture at these wave-

lengths. (3) Solution of the n simultaneous linear equations (one for each wavelength) of the type (3) for the mole fractions x.

As no spectrograph works with strictly monochromatic radiation, the accuracy of analysis is limited by the deviation from Beer's law. It has been found possible to improve this accuracy by a method based on the assumption that: The optical density of a mixture equals the sum of the optical densities of the components even though the optical density of an individual component is not expressible as the product of a constant and the concentration. The apparatus is calibrated as follows: (1) The curve presenting the optical density plotted against mole fraction is determined for each of the n pure components at each of n selected spectral positions. In the general case these curves are not straight lines, so that the extinction coefficient ϵ_n of Eq. (2) is not a constant as x_n changes. (2) Using the data of step 1, values of the extinction coefficients are chosen so that the difference terms of step 4 below are reasonably small and the n simultaneous linear equations of the type (3) are solved considering these chosen values to be constants. This gives the mole fraction of each component as a linear function of the optical densities of the mixture measured at the n selected spectral positions:

$$x_j = \gamma_j^{(1)} D^{(1)} + \ldots + \gamma_j^{(n)} D^{(n)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where the subscript refers to the component, the superscript to the spectral position, and $\gamma_j^{(n)}$ are numerical constants. (3) The theoretical curve of optical density plotted against mole fraction for each of the components at each spectral position is calculated from Eq. (2) using the extinction coefficients chosen in step (2). (4) The differences between the optical densities calculated in step 3, and the experimental optical densities of step 1 are plotted against mole fraction for each component at each spectral position. The results of the calibration steps 1, 3, and 4 can be used in analyzing for the same component in different mixtures while calibration step 2 has to be done for each particular mixture, but only once for all samples of this mixture.

The analysis is then performed as follows: (1) The optical densities of the sample are determined at each of the selected spectral positions. (2) Eqs. (4) are solved arithmetically for the mole fractions, using the experimentally determined optical densities D of step 1. These mole fractions are only approximate, since the true extinction coefficients were not used in solving for Eqs. (4). (3) The experimental optical density at each spectral position is now corrected to a new value by adding to it the sum of the differences between the true and assumed optical densities for each component at this spectral position. These differences are obtained from the curves of calibration step 4, using the mole fractions from analysis step 2. These correct optical densities are the values which would have been experimentally determined at each spectral position if the optical density of each conponent were given by the theoretical curves of calibration step 3. (4) Eqs. (4) are again solved arithmetically for the mole fractions using the values of optical density D determined in step 3. Steps 3 and 4 are repeated until the values of the mole fractions are constant. For the samples so far analyzed one or two corrections have been sufficient.

The application of the method to infra-red absorption of vapour samples is described in detail. The results of tests using a six-component C_4 hydrocarbon mixture are given. The method is especially useful for the rapid routine analysis of large numbers of samples containing the same components, and therefore is well suited for plant-control purposes. A. H. N.

1177. Patents on Chemistry and Physics of Hydrocarbons. Standard Oil Development Co. E.P. 553,920, 10.6.43. Appl. 30.12.41.—In the isomerization of straight-chain paraffins to the corresponding branched-chain isomers, it has been found that previously unused aluminium halide has a different degree of catalytic activity from the same aluminium halide after having been used as catalyst in a different isomerization reaction. The process described is designed to utilize more effectively the inherent variation in catalytic activity for isomerization of the various aluminium halides in the presence of the conventional promotors.

Standard Oil Development Co. E.P. 554,315, 29.6.43. Appl. 27.1.42. In order to increase and modify to some extent the activity of aluminium halide catalysts, varying proportions of one or more of either the same or corresponding halides of

other metals may be mixed with them. By modifying the catalyst composition to compensate for the inherent reactive tendencies of any particular feed-stock, it is possible for the ordinary plant operator to exercise a lower degree of care and yet obtain the final desired product. H. B. M.

Analysis and Testing.

1178.* A Modification of the C.F.R. Bouncing Pin Spring-Tension Balance and Instructions for Use. P. Draper. *J. Inst. Petrol.*, September 1943, **29** (237), 253–257.—The spring-tension balance designed in the Shell Laboratories, and described in the *J. Inst. Petrol.*, Vol. 28, p. 209, had proved so successful, particularly in enabling repeatable octane ratings to be obtained in the range of 90–120 O.N., that the Institute of Petroleum requested the C.F.R. Committee in America to co-operate by designing a less costly apparatus. This has been done very successfully by the Ethyl Gasoline Corporation Yonkers' Laboratory, and the instrument, which is described in this report, has certain advantages over the original model. All necessary details on the construction and use of the balance are given. A. H. N.

1179.* Emergent-Stem Correction Nomograph. J. G. Kane and H. A. Schuette. *Petroleum*, October 1943, **6** (10), 155.—A nomograph is presented for calculation of emergent-stem correction. A. H. N.

Motor Fuels.

1180. Patents on Motor Fuels. Standard Oil Development Co. E.P. 554,095, 21.6.43. Appl. 31.7.40. The object of this invention is to produce a finished stabilized motor fuel in a single unitary process without having to acid or clay treat. The fuel is prepared by applying to a hydrocarbon oil boiling in the gasoline range two consecutive reactions. Firstly, dehydrogenation and aromatization processes are carried out in the presence of hydrogen, but only so long as there is a net production of free hydrogen. Then hydrogenation is carried out in the presence of the free hydrogen produced in the first reaction.

International Catalytic Oil Processes Corp. E.P. 554,653, 14.7.43. Appl. 2.7.41. Aviation fuel of high anti-knock characteristics is prepared by subjecting a light naphtha fraction and a heavy naphtha fraction to separate and independent reforming treatment, in the presence of hydrogen. The reforming treatments are carried out in the presence of a catalytic material capable of improving the anti-knock characteristics of each fraction. Products resulting from reforming of the light naphtha are separated into a low-boiling and a higher-boiling fraction. A fraction having an end-point of 300° F. obtained from reforming the heavy naphtha is combined with a reformed light naphtha fraction boiling between 230° and 300° F.

Standard Oil Development Co. E.P. 554,796, 20.7.43. Appl. 18.12.41. The object of this invention is to confer upon hydrocarbon motor fuels high immunity to explosion and inflammability under a wide variety of service conditions, with the least possible detraction from the volatility and anti-knock qualities of the fuel. To achieve this, 0·5–5% by volume of a non-inflammable aliphatic organic halide boiling below 142° F. is blended with a hydrocarbon fraction boiling substantially within the gasoline boiling range.

V. Biske. E.P. 554,872, 22.7.43. Appl. 24.2.42. A process is described for preparing fuels for use in internal-combustion engines using ultrasonic sound vibrations, *i.e.*, sound-waves having a frequency in excess of 20 kHz and preferably in the range of 100–1000 kHz. By means of these vibrations it is possible to disperse water throughout and form a stable mixture with a hydrocarbon fuel with which it would otherwise be immiscible.

Shell Development Co. E.P. 555,046, 30.7.43. Appl. 18.3.42 In the production of aromatic hydrocarbons from aliphatic hydrocarbons having 6–12 carbon atoms, the original hydrocarbons are treated under cyclizing conditions with a catalyst containing a cyclizing compound of a metal selected from the left-hand columns of

Groups IV to VI of the Periodic Table, supported upon a stabilizing carrier of relatively low catalytic activity. The catalyst is promoted by the presence on it of platinum and/or palladium.

Standard Oil Development Co. E.P. 555,288, 16.8.43. Appl. 2.1.42. Process for the isomerization of mono-olefins in which straight-chain mono-olefins or olefins containing not more than one side-chain attached to any one carbon atom are converted into branched-chain olefins having the same number of carbon atoms but a greater number of side-chains than the original olefins. The olefin feed is contacted at a temperature between 400° and 1200° F. with a catalyst consisting of boron oxide carried on alumina or silica, for a period of from 0·05 to 60 seconds.

E. C. Lee and J. E. Ahlberg. U.S.P. 2,316,260, 13.4.43. Appl. 29.4.39. Hydrocarbon oils heavier than gasoline are converted by subjecting them at a temperature between 850° and 1100° F. to the action of a synthetic catalyst substantially devoid of alumina and alkali metal ions and consisting of a calcined mixture of a precipitated silica hydrogel and a precipitated hydrous oxide of tin.

A. R. Goldsby. U.S.P. 2,317,142, 20.4.43. Appl. 27.4.39. An improved method is described for the production of aviation spirit of high anti-knock rating by alkylating isobutane with a low-boiling olefin in the presence of an alkylation catalyst.

E. B. Hjerpe and W. A. Gruse. U.S.P. 2,317,603, 27.4.43. Appl. 25.3.36. In the manufacture of gasoline-like hydrocarbons of high anti-knock value from normally gaseous hydrocarbons by a polymerizing process, a fraction is used which consists predominantly of saturated and unsaturated hydrocarbons having four carbon atoms per molecule and having relatively small amounts of hydrocarbons having three carbon atoms per molecule. It is substantially free from refractory hydrocarbons such as methane, ethane, and ethylene.

A. P. Hewlett and G. E. Phillips. U.S.P. 2,317,766, 27.4.43. Appl. 3.1.40. Motor fuels of high anti-knock value are obtained by contacting petroleum feed-oils with bauxite at a temperature between 800° and 850° F. The feed-oils are characterized by having an acid heat above 150 and a clear octane number below 70. H. B. M.

Lubricants and Lubrication.

1181. Tall Oil in Lubricants. Anon. *Chem. Tr. J.*, 28.5.43, **112**, 504.—A new emulsified lubricating or cutting oil made chiefly from tall oil has been developed by one of Sweden's largest manufacturers of motor vehicles and machine tools. Tests extending over six months in the operation of various types of machine tools have given successful results. D. L. S.

1182. Radiosulphur Tracer Study of Sulphurized Lubrication Addition Agents. G. L. Clark, S. G. Gallo, and B. H. Lincoln. *J. appl. Phys.*, August 1943, **14** (8), 428.—Radioactive tracer techniques have been used to ascertain the concentration of sulphurized addition agent in lubricating-oil blends on metallic surfaces, the active element being radiosulphur prepared with the cyclotron and introduced into the olefin molecules. Film formation seems to be quite general, having been tested on seven different types of commercial metallic bearings as well as on glass. The film is transparent and very thin. In extreme cases it imparts a faint opalescence to the bright surface. The organic molecules may form a loose molecular compound with the metal or a polymerized film, sufficiently adherent, however, to resist the solvent action of benzene and carbon disulphide. The rate of film formation has been established at 88° C. (190° F.) and at room temperature for a typical bearing composition. It has been found that the rate at room temperature though several times slower than at 88° C. is still quite appreciable and favourable from the standpoint of engine protection. The mechanism of oxidation inhibition, and thus retardation of corrosion and sludging, with this addition agent seems to embrace both alteration of surface character of catalyzing metals and bulk or liquid phase inhibition in the oil. The adherent organic film is probably involved in "oiliness" (film strengthening and prevention of complete oil drainage from motor bearings and walls by anchoring through polar molecules), since engine tests have shown that the oiliness of straight mineral oil is appreciably improved by addition of sulphurized olefins. A. H. N.

1183. Temperature Relations in Journal-Bearing Systems. M. Muskat and F. Morgan. *J. appl. Mech.*, September 1943, **10** (3), A131–A138.—The basic principle underlying the method of investigation which has been followed in the present paper was outlined in a discussion of the paper presented by Hersey at the symposium. This consisted essentially in the proposal that film or bearing-surface temperatures be inferred from measurements of the friction torque acting either on the journal or bearing. The practicality of this proposal lies in the observation that the theoretical calculations of friction conditions in journal-bearing systems, for constant-lubricant viscosity, have reached a stage where the values of the friction torque can be accurately computed for a wide range of operating conditions and physical dimensions of the journal-bearing system. Hence by comparing such calculated friction torques with those actually measured, it should be possible to determine the effective equivalent constant-film viscosity corresponding to the operating conditions imposed on the journal-bearing system. Combining the film viscosities computed in this way with the viscosity–temperature characteristic of the lubricant used, the equivalent average film temperature can thus be really determined. This has been the principle of the present method of investigation. In its actual application, advantage was taken of the great simplification associated with the thick-film operation of the journal bearing—*i.e.*, by experimenting at high speeds and low loads where the simple Petroff formula should accurately predict the frictional behaviour.

In the course of these experiments, the transient history of the film or bearing temperature was observed and recorded, from the beginning of operation of the journal bearing until thermal equilibrium had been approximately approached. It was found possible to correlate the rate of asymptotic approach to equilibrium to the actual equilibrium conditions. It was also possible to correlate the latter with the operating parameters of the system. In addition to the experimental measurements, theoretical considerations are presented pertaining to the temperature distribution with the lubricant film, and also the problem of calculating effective film temperatures in journal-bearing systems provided with sufficiently great rates of lubricant flow as to materially influence the thermal-equilibrium conditions.

The need for more experimental work is emphasized. A. H. N.

1184.* Development and Application of Lubricating Greases. Part 2. M. W. Webber. *Petroleum*, October 1943, **6** (10), 148–149.—Very brief paragraphs describe the tests generally conducted on greases. These include drop and melting points, consistency and viscosity, stability tests of different types, and performance tests. Application of greases by screw-cups, automatic cups, ordinary and pressure guns is also briefly discussed. A. H. N.

1185. Patents on Lubricants and Lubrication. J. G. Fife. E.P. 553,234, 13.5.43. Appl. 8.9.41. A mineral lubricating oil suitable for use in internal-combustion engines has dissolved in it 0·25–5% of a sulphonate salt and one or both of the following: 1–10% of a sulphurized ester and 0·20–2% of an anti-oxidant selected from the group consisting of aromatic amine and hydroxy anti-oxidants. The sulphonate salt must be oil-soluble, free from free acid, and it must combine a hydrocarbon sulphonic acid with a polyvalent metal which forms an oxide that is not readily converted into other oxides under lubricating conditions.

Shell Development Co. E.P. 553,562, 27.5.43. Appl. 21.7.41. A mineral oil or a compounded oil containing more than 20% of mineral oil is used for the lubrication of textile fibres. The oil compositions may be prepared by the addition to mineral oils of a partial ester or esters of a polyhydric alcohol, such as glycol, glycerol, with a fatty acid containing more than 8 carbon atoms in the molecule. In use, the mineral-oil compositions have been found to have scouring properties equal or superior to those of fatty oils, such as olive oil, and are readily removed from textile fibres.

Socony-Vacuum Oil Co. E.P. 555,053, 3.8.43. Appl. 23.4.41. Preparation of a mineral-oil composition consisting of a viscous mineral-oil fraction and a small proportion of an oil-miscible metal-organic compound. The compound has at least two aryl nuclei, each substituted with a wax group and with a metal or metallo-group, interconnected by at least one atom of an element selected from the group consisting of sulphur, selenium, and tellurium.

Standard Oil Development Co. E.P. 555,081, 4.8.43. Appl. 2.9.40. Addition agents for lubricating oils are prepared by condensing a mono or polycyclic aromatic hydrocarbon, or a halogeno derivative thereof, with a polyhalide of a low-molecular-weight hydrocarbon, and with a monohalide of a low-molecular-weight saturated hydrocarbon, or a low-molecular-weight olefin, in the presence of a condensing agent. Examples of aromatic hydrocarbons and derivatives used are benzene, naphthalene, anthracene, and phenanthrene.

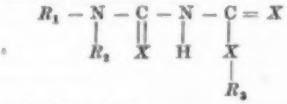
U. B. Bray and C. E. Swift. U.S.P. 2,316,395, 13.4.43. Appl. 19.2.35. Lubricating oil is produced from an oil which contains wax by mingling with the original material a liquid having a selective solvent action as between paraffinic and non-paraffinic fractions of the oil, also a relatively less selective solvent. In this way are formed an extract phase of selective solvent and non-paraffinic fractions, and a raffinate phase of the two solvents and paraffinic fractions, including wax. The raffinate phase is cooled and the wax is afterwards removed from it. H. B. M.

Sin-Iti Irigai. U.S.P. 2,316,587, 13.4.43. Appl. 4.1.41. A petroleum hydrocarbon oil is stabilized against oxidation by the addition of 0·01–1·0% by weight of diphenyl piperazine.

F. E. Armfield. U.S.P. 2,316,852, 20.4.43. Appl. 30.8.41. The catalytic oxidation of a lubricating or electrical oil caused by sludge containing a catalyst of the group consisting of copper, iron, chromium, lead, and their compounds, is inhibited in the following way. A small amount each of a phosphatide and a metal deactivator are added to the oil. The metal deactivator is selected from the class consisting of the reaction products of a primary amine and a β-carbonyl compound.

O. M. Reiff, F. P. Otto, J. J. Giammaria, and E. A. Oberright. U.S.P. 2,316,889, 20.4.43. Appl. 20.1.40. A mineral-oil lubricant has added to it a small proportion of an alkyl-substituted aromatic-aliphatic carboxylic acid in which a carbon atom of the aromatic nucleus is directly attached to a carbon atom of the aliphatic group, and in which the alkyl substituent is attached to the aromatic nucleus, and is derived from an aliphatic hydrocarbon material having at least 23 carbon atoms.

P. R. van Ess and E. R. White. U.S.P. 2,316,903, 20.4.43. Appl. 26.12.41. To improve a mineral lubricating oil a small amount of an allophanate is dissolved therein. The addition agent has the general formula :



R_1 and R_2 are radicals selected from the group consisting of hydrogen and hydrocarbon radicals, R_3 is a radical having at least 6 carbon atoms selected from the group consisting of aliphatic, alicyclic, aromatic, and mixed cyclic and chain radicals. X is a radical selected from the group consisting of oxygen and sulphur.

A. W. Burwell and J. A. Camelford. U.S.P. 2,317,666, 27.4.43. Appl. 8.5.40. A lubricating composition is prepared from a mineral oil and an oil-soluble mixture of a number of different thio-alkyl compounds produced by reacting with phosphorus hepta-sulphide, a mixture of oxygenated, saturated aliphatic hydrocarbons, including alcohols, ketones, and carboxylic acid compounds, derived from a petroleum hydrocarbon mixture by partial oxidation.

P. K. Frolich and A. H. Gleason. U.S.P. 2,317,751, 27.4.43. Appl. 26.9.41. A lubricant is prepared from a viscous hydrocarbon oil and a small amount of a high-molecular-weight condensation polymer of an organic diamine and a dibasic organic acid. The polymer has a branched long-chain structure of interlinked recurring units, each of which contains at least 8 carbon atoms in branched side-chain hydrocarbon groups. The polymer further has a total hydrogen and carbon content of 80%.

Asphalt and Bitumen.

1186. Patents on Asphalt and Bitumen. E. Vannan. E.P. 554,950, 27.7.43. Appl. 27.2.42. Light-weight asphalt aggregates can be prepared by a heat process and with-

out damaging the constituents by agitating the ingredients in a mixer to which heat is applied by circulating a hot fluid through a jacket surrounding the mixer. Any suitable fluid capable of achieving the requisite temperature may be used—*e.g.*, heavy lubricating oil introduced into the jacket through a thermostatically controlled supply. The following is an example of the type of mix which can be so prepared: Wood flour 16%, pitch 64%, grit 20%, by weight.

E. H. Nichols. U.S.P. 2,316,357, 13.4.43. Appl. 9.8.43. To retard deterioration of a bituminous coating mixture, consisting of asphalt and a filler of finely powdered slate, a retarding agent is distributed throughout the composition in the following way. The retarding agent is first heated, and then the slate particles are coated with it. The asphalt is heated, and thus rendered sufficiently fluid to mix thoroughly with the coated slate particles. H. B. M.

L. L. Lovell, D. C. Isted, and R. L. Ortynsky. U.S.P. 2,317,150, 20.4.43. Appl. 12.5.41. During the process of manufacturing asphalts by oxidizing a precipitated asphalt and blending with a flux, air is used as the sole oxidizing agent, and a blown asphalt is produced having an asphaltene content of 45–65%. The original asphalt has an asphaltene content under 20% and a resin content over 40%, and is obtained from a crude-oil short residue having a viscosity over 300 S.S.W. at 210° F. The blown asphalt is blended with a flux having a high dispersing power for asphaltenes.

J. M. Johnson and E. C. Brown. U.S.P. 2,317,959, 27.4.43. Appl. 1.3.41. A bituminous composition is prepared from an asphaltic material, a water-insoluble soap, and an amide of a higher fatty acid constituting an emulsifier adapted, when in contact with the insoluble soap and water, to cause emulsions of the water-in-oil type. The composition is characterized by thoroughness of contact and lasting adherence to stony aggregate incorporated in a wet condition.

Special Products.

1187. Relation of Composition to the Efficiency of Foliage- or Summer-Type Petroleum Fractions. P. J. Chapman, G. W. Pearce, and A. W. Avens. *J. Econ. Ent.*, April 1943, **36** (2), 241.—Emulsions from a range of petroleum oils varying in chemical composition and with viscosities of 54/80 secs. S.U. at 100° F. have been tested during three seasons to determine their ovicidal efficiency on codling moth, oriental fruit moth, and the eye-spotted bud moth. Using standard spraying equipment, egg-bearing leaves of apple and quince trees were sprayed out-of-doors and then transported to a greenhouse to enable the percentage survivors to be determined. Quantity of oil deposit was determined by extraction with petroleum ether of discs punched from the leaves. The oils were classified chemically by unsulphonated residue, density, aniline point, refractive index, specific refraction, and specific dispersion tests. There was no consistent difference found in the effect of any one spray on the three types of eggs. Determinations of the minimum dosage to give 95% kill of the eggs revealed that there was a wide difference between standard summer oils of similar unsulphonated residue content, but that toxicity was closely in line with paraffinicity. Thus aromatic hydrocarbons are regarded purely as diluents (as far as the above eggs are concerned), while paraffin hydrocarbons are more toxic than naphthenic. A highly refined white oil is thus more effective than a less refined oil. Viscosity appears to be of little significance, as far as the above range is concerned, it being a function of molecular weight and chemical composition. The molecular weight is regarded as of much less importance than the chemical composition. Further work on this aspect of the problem will be reported later. C. L. G.

1188. An Outline of the Relationship Between Asphaltic Bitumens, Petroleum Resins, and Aromatic Petroleum Residues. R. H. H. Morley. *J. Oil and Colour Chem. Assocn.*, April 1943, **26**, 55.—Following a brief indication of the classification of crude oils and of normal refining operations for the production of lubricating oils and asphalts, the origin and general characteristics of petroleum resins and aromatic petroleum residues are discussed. Petroleum resins, or light bitumens, are brown-coloured bitumens, substantially free from asphaltenes, derived from special crude oils—*e.g.*, Miri—or from high-molecular-weight aromatic petroleum residues, or from black asphaltic bitumen by removal of asphaltenes and concentration of the brown residue

remaining. Aromatic petroleum residues are the viscous, high-molecular-weight extracts removed from heavy lubricating oil by solvents such as furfural, phenol sulphur dioxide, etc., owing to their low viscosity index, poor resistance to oxidation, and tendency to form gums. The last-mentioned characteristic leads to their use as drying oils in the paint industry. Drying time tests on a typical A.P.R. using varying percentages of cobalt, manganese, and combinations of these driers indicate the advantage of combining these two driers; 1% of cobalt is required to produce a drying time of 12 hrs., while up to 2% manganese has no effect on the drying time (150 hrs.). On the other hand, a combination of 0·4% cobalt and 0·2% manganese gives a 12-hr. drying time. Asphaltic bitumen may be of the steam-refined type, the blown type, or a third brittle type obtained by distillation of cracking residues. The blowing of A.P.R.'s yields blown-type bitumens. It is concluded that the materials constituting aromatic petroleum residues, petroleum resins, and asphaltic bitumens are in general all present in the heavy residual oil obtained after the initial distillation of crude petroleum oils, particularly when these are of the same asphaltic types. Further, in general, A.P.R.'s such as are used as binders in the paint industry, and black asphaltic bitumens both contain brown petroleum resins, because by physical methods it is possible to derive such resins from each. Black bitumens, however, also contain asphaltenes—polymerized or condensed non-volatile cycle hydrocarbons. The Pfeiffer and van Doormal theory of the constitution of bitumen is outlined, and analyses by Thurston and Knowles of the composition of a Mexican asphaltic bitumen given. C. L. G.

1189.* Thiokol—Rapidly Developed Commercial Synthetic Rubber. J. W. Crosby *Petrol. Engr*, June 1943, **14** (10), 96.—The superior resistance to oil, gasoline, and oxidation, and the impermeability to gases of Thiokol led in pre-war days to its use in fuel lines, for electrical insulation, press blankets, rollers and plates for the printing trade, paint spray-hose, washers, etc. It was also available in powder form for moulding, or in solution for impregnation of fabrics and paper. The present emergency has led to other uses—*e.g.*, emergency self-sealing tanks and impregnated cotton bags for transporting fuel, linings for underground cement storage reservoirs, etc. In powder form, insoluble in any known solvent, it is used for abrasive and water-resistant coatings to propeller shafts and shaft supports, submarine submersion tanks, etc. As a coating on felt it replaces sponge rubber cushioning and gaskets on army trucks, etc. The production of Thiokol from non-critical materials has also led to its use in tyres, particularly for recapping, Thiokol N recaps giving 8000–10,000 miles of service. In addition to the dried material obtained by coagulating the reaction products from sodium polysulphide and ethylene dichloride, an uncoagulated Thiokol latex is now available, being used for airplane gas-tank bladders, cement storage-tank linings. A special Thiokol (Vitrobond) is also used for the bonding of brick linings—*e.g.*, in pickling tanks for steel production. C. L. G.

1190.* Sulphur Products from the Aluminium Chloride Complex Obtained in Refining High-Sulphur Gasolines. I. I. Tsyganok and L. A. Yanyukova. *Petrol. Engr*, July 1943, **14** (11), 75. (Translation from *Vostochnaya Neft*, No. 9, 1940.)—The great possibilities inherent in the aluminium-chloride method of desulphurizing distillates has led to a study of the complex reaction products separated by the treatment, with a view to finding methods of utilizing them. Treatment of a gasoline, previously treated with caustic soda, with 3% of Al_2Cl_6 reduced the sulphur content from 0·35% to 0·04% and gave 1·44% of a fluid complex from which 0·54% of an organic substance containing 8·33% S and 0·325% Cl was recovered by decomposition with water. On distillation the latter product gave as residue a black viscous product with a dark red shade and a specific gravity over 1, which dries slowly to an even solid film soluble in gasoline. The sulphur compounds in the distillate (which amounted to 8·92% of the distillate) were distributed as follows: mercaptans 4·14%, disulphides 15·01%, sulphides 71·30%, and residual sulphur 9·55%. Increasing the amount of Al_2Cl_6 used gave high yields of complex and extracted organic matter (thus 9% gave 4·78% of complex and 1·00% of organic matter). The distillates were excellent solvents for rubber, and have possibilities for use in chemical industry as a raw material for the preparation of mercaptans or sulphides. C. L. G.

1191. Plastics Tested for Brake Cylinder Pistons. Anon. *Brit. Plastics*, August 1943, **15**, 144.—At a recent meeting of the S.A.E. in Detroit, J. F. Bachman gave a report on wheel cylinder pistons made from various materials, including plastics, as substitutes for aluminium. Lignin phenolic resins were found unsatisfactory owing to swelling and etching by the hydraulic-brake fluid. Of the phenolic materials tested, the telephone-receiver stock gave the best results, showing only very slight shrinkage in brake fluid, but the strength was not quite satisfactory with steel inserts. A composite piston with a Durez No. 1544 plastic skirt on a hardened steel head was very satisfactory for head strength, life, corrosion resistance, and inertness to brake fluids. It has distinct possibilities, but it is not yet known whether pistons of this type could be produced on the large scale. C. L. G.

1192. New Type Plastics Material. Anon. *Brit. Plastics*, August 1943, **15**, 181.—It is reported that the Dow Chemical Co., in co-operation with the Corning Glass Co., has developed a range of plastic materials (Silicones) differing from present types in having a melting point of about 500° F. They are compounds of silicon dioxide with methyl or ethyl groups, or with ethylene chloride or phenol. They may be used in liquid form, in which state their viscosity is independent of temperature. In view of their heat stability, they have great possibilities in electrical and high-frequency insulation, etc., though they are at present still in the experimental stage.
C. L. G.

1193. Sugar-Cane Wax. Anon. *Chem. Tr. J.*, 13.8.43, **113**, 158. (Abstract of article in April–June issue of *Bulletin of the Imperial Institute*).—Sugar-cane wax occurs in a thin layer on the stalks of the cane, to the extent of 0·1–0·5% of the total weight. It is recovered by solvent extraction of the mud-press cake, which contains up to 17% of crude wax, from the filtration of the expressed juice. Production in Natal commenced in 1916 and increased up till 1924, when 5000 tons were exported, but subsequently decreased, owing to competition, and was discontinued in 1930. The possibility of production in Louisiana has now been considered, a pilot plant being set up at Houma, La. It is hoped to produce 3000 t.p.a. of a product superior to the Natal wax, which was dark, sticky, and of an unpleasant odour. The suitability of different solvents is being investigated, no difference having been found between benzole, toluole, and 95–103° C. petroleum naphtha. Removal of fatty matter present (to the extent of 20–45%) is effected by a diffusion process using cold acetone. The extracted wax is hard and of a green colour, due primarily to chlorophyll, and is difficult to bleach. The fatty fraction contains a component melting at about 132° C., which is probably a mixture of phytosterols. The product should be useful as a substitute for carnauba wax, particularly if the colour can be improved. C. L. G.

1194. Preliminary Experiments on the Use of Oil-Soluble Copper Compounds as Fungicides. C. J. Hickman, R. W. Marsh, and E. H. Wilkinson. *Ann. appl. Biology*, August 1943, **30** (2), 179.—The usual method of improving the adhesion and penetration of fungicidal copper compounds is to mix a suspension in water of the compound with an oil emulsion. The possibility of using oil-soluble copper compounds in order to obtain improved contact has now been investigated. The copper compounds used were salts of the following acids: oleic, palmitic, stearic, linoleic, chaulmoogric, sulphoricinic, abietic, adipic, sebacic, benzoic, di-nitro-*o*-cresol, salicyclic, and 3 : 5-di*iso*propylsalicylic. The last-mentioned was the only one soluble (to the extent of 0·22% Cu) in the oils used (white oil, white spirit, cottonseed oil, turpentine, and pine oil). The others gave suspensions, some of which could be dispersed, or were insoluble in these oils. Laboratory phytocidal tests were carried out on the basic oils and on copper D.I.P.S. at 0·01% Cu in white oil and in water, only pine oil, white spirit, and turpentine causing damage. Field tests on onions with the white oil alone and with 0·01% Cu as D.I.P.S. confirmed these results, but 0·1% Cu as D.I.P.S. in white oil caused shrivelling of the leaves, the plants recovering after a month. Laboratory fungicidal tests showed that copper D.I.P.S. in white oil gave better results than in water, the latter results being on a par with those given by Bordeaux mixture of equivalent copper content. Field fungicidal tests on control of downy mildew on onions, however, showed no control with Cu D.I.P.S. This may have been due to

the fact that spraying was carried out at the end of May, June, July, the mildew appearing shortly before the final application, when the effectiveness of the spray deposit had been lost by weathering, while there was considerable growth of new and hence unprotected foliage. Further trials will be made giving more frequent applications at the critical period. C. L. G.

1195. Patents on Special Products. Standard Oil Development Co. E.P. 553,297, 17.5.43. Appl. 30.10.40. A method is described for the production of β-olefins from α-olefins, in particular butene-2 from butene-1. At least one α-olefin is contacted with sulphuric acid of 50–80% concentration at a temperature between 100° and 220° F., for a period of 5–60 minutes, with vigorous agitation. At least one β-olefin is recovered from the reaction mixture.

Anglo-Iranian Oil Co. E.P. 553,599, 28.5.43. Appl. 2.10.40. A process is claimed for the production of branched-chain alkanes, such as *iso*butane or *iso*pentane, from the corresponding straight-chain alkane, such as *n*-butane or *n*-pentane, or for the production of such hydrocarbons from normal hydrocarbons of high molecular weight. An aluminium halide, generally aluminium chloride, is used as catalyst, and the process is carried out in liquid phase in either a continuous or discontinuous manner, at high temperatures and under super-atmospheric conditions. Loss of catalyst from the reaction chamber is avoided by employing a cyclic process as described in the patent.

Shell Development Co. E.P. 554,124, 22.6.43. Appl. 18.9.41. Process for the production of halogenated ethers by halogenating an unsaturated ether in which each of the two radicals directly linked to the ether oxygen atom contains an olefinic linkage between two carbon atoms, each of which is linked to at least one hydrogen atom and neither of which is directly linked to the oxygen atom. The halogenation is effected by reacting the unsaturated ether with a halogen under such conditions that a liquid phase is present in the reaction zone.

Standard Oil Development Co. E.P. 554,974, 28.7.43. Appl. 12.11.41. In a process for isomerizing paraffinic hydrocarbons at least one paraffinic hydrocarbon containing at least four carbon atoms per molecule is contacted at a high temperature with a catalyst composition consisting of a hydro-halide acid-treated clay, containing at least one metal from the group consisting of iron, cobalt, and nickel, in the presence of free hydrogen.

Remington Arms Co. E.P. 555,826, 9.9.43. Appl. 16.7.41. An improved bullet lubricant consists of a mixture of a solid lubricant and a small proportion of a microcrystalline petrolatum wax. The solid lubricant preferably consists of a mixture of petrolatum wax with one or more lower-melting substance—*e.g.*, various grades of paraffin scale, paraffin wax and petrolatum, ozokerite, oleostearine, and mixtures of solid fatty alcohols containing at least 14 carbon atoms in the molecule.

A. L. Mond. E.P. 555,861, 9.9.43. Appl. 20.3.42. In the production of branched-chain paraffin hydrocarbons from less branched aliphatic hydrocarbons, the latter are contacted in the presence of added hydrogen and a hydrogen halide with a composite of an active-olefin hydrogenating catalyst consisting of a reduced metal and a paraffin-isomerizing catalyst consisting of a metal halide, at a temperature between 50° and 300° C.

V. N. Ipatieff and H. Pines. U.S.P. 2,316,247, 13.4.43. Appl. 12.1.40. Process for the isomerization of paraffin hydrocarbons to produce substantial yields of more highly branched compounds. The original material, mixed with a hydrogen halide, is contacted with a granular composite of substantially anhydrous chlorides of aluminium and zirconium and a relatively inert adsorbent under isomerizing conditions of temperature and pressure.

V. N. Ipatieff and H. Pines. U.S.P. 2,316,248, 13.4.43. Appl. 12.1.40. Process as described in U.S.P. 2,316, 247, except that the paraffin hydrocarbons, in admixture with a hydrogen halide, are contacted with a granular composite of substantially anhydrous chlorides of aluminium and copper. H. B. M.

Detonation and Engines.

1196.* Effect of Friction in Air-Inlet and Exhaust Systems of Internal-Combustion Engines. Part 2. O. Adams. *Petrol. Engr*, August 1942, **13** (12), 92.—The flow of gases in ducts and pipes has been studied experimentally, and a number of equations have been deduced. These indicate that friction losses in duct systems are affected by the size, shape, surface roughness, and length of the pipe. The following laws have been found to govern such systems:

1. Frictional resistance varies approximately as the square of the velocity.
2. Frictional resistance varies directly with the area of contact between fluid and duct, and also with the density of the fluid.
3. The total frictional resistance is independent of its pressure against the wall of the duct.
4. The nature of the surface of the duct has a great influence. Smooth surfaces offer less resistance to flow than rough surfaces.
5. Obstructions such as baffles, filters, etc., and any fitting that changes the direction of flow will offer resistance to the flow of the fluid. D. L. S.

BOOK REVIEW.

Beitrag zur Kenntnis der Schmieröle und Treibstoffe für Dieselmotoren (Part I). By H. Stäger and H. Künzler.

The study of the mechanism of alteration and deterioration of mineral oils in use is one which has commanded considerable attention in the past, and which still warrants the continued development of methods of examination and procedure.

The authors of the papers under review are aware of the comparative lack of knowledge regarding the mechanism of deterioration, and maintain that as general analytical data on mineral oil are insufficiently characterized, new methods of test should be sought. For example, a study of the development of turbidity in oils during use has been made, and for this purpose a modification of the Kauri–Butanol test, including electrical measurements embodying a photoelectric cell, has been employed.

The authors have studied turbidity development in paraffinic- and naphthenic-base oils and also the effect of temperature thereon.

A description is given of the effects produced by the two types of oil when small quantities were dropped on a heated aluminium bar. The results are compared with the build-up of deposit around the inlet ports of Diesel engines.

One of the most promising lines of research by the authors is the analysis of the products of alteration or deterioration by means of selective solution using alcohol, petroleum ether, benzol, and chloroform. Paraffinic, naphthenic, and mixed-base oils have been used in this series of experiments, and results reproduced in graphical form show the method to be promising.

The work is to be continued. (For a review of Part II, see *J. Inst. Petrol.*, Jan. 1943, **29** (229), 28A.) W. H. Thomas.

BOOKS RECEIVED.

Annual Reports of the Society of Chemical Industry on the Progress of Applied Chemistry. Vol. XXVII. 1942. Issued by the Society of Chemical Industry, 56, Victoria Street, London, S.W.1. Pp. 492. Indexes 493–545.

This collection of reports contains twenty-six papers, each a condensed record of the notable researches during 1942 in the particular industry under review. Of special interest to the Petroleum Industry is the chapter on "Mineral Oils" contributed by Mr. W. W. Goulston, who reviews the outstanding developments in each section of the industry—viz., petroleum substitutes, refinery plant, motor spirit, lubricating oils, fuel oil, asphaltic bitumen, cracking, isomerization and alkylation, special products, and analysis and testing.

Review of the Work of the Joint Research Committees, 1924–1943, of The Iron and Steel Institute and The British Iron and Steel Federation. Special Report No. 29. Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1. Pp. 167. Price 10*s*. (Members 5*s*.)

Electric Arc Welding Manual. Vol. I.—Equipment. Pp. 126. Murex Welding Processes, Ltd., Hertford Road, Waltham Cross, Herts.

This handbook has been prepared to give assistance to those not previously experienced in the type of equipment required for electrical welding. There are chapters on "The Electric Arc when used for Metallic Arc Welding," "Motor Generator Arc-Welding Sets," "Engine-Driven Arc-Welding Sets," "Multi-operator Arc-Welding Equipments," "Transformer Equipments," etc., etc.

Transactions of the Institute of Marine Engineers. Vol. 54. Session 1942–43. Pp. 197. Published by the Institute, London.

Thirteen papers read before the Institute during the 1942–43 Session are reproduced, including one on diesel installations, viz: "Operation of Diesel Machinery in Cross-Channel Vessels" (J. W. Coulthard).

Handbook of British Standards No. 1, 1943. Pp. 152. British Standards Institution, 28, Victoria Street, London, S.W.1. Price 1*s.* 6*d.*

The Handbook includes the report of the work of the Institution during the period of eight months to 31st May, 1943. A numerical list of British Standards and a subject index to the list of British Standards are also given.

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WAR-TIME SPECIFICATIONS FOR I.P. THERMOMETERS

The Standardization Committee was recently reorganized, and a number of new sub-committees were set up, including one to deal with apparatus.

One of the most important functions of this Apparatus Sub-Committee is to ensure that all recommended or standardized apparatus is constructed on sound practical lines, and in this connection it has been fortunate in securing the co-operation of expert representatives from the three major trade associations dealing with scientific instruments, laboratory equipment and glassware.

The first task of the Apparatus Sub-Committee has been to reconsider the whole of the existing thermometer specifications. Under war-time conditions it is vital that the best use should be made of the limited skilled labour and specialized material available, and with this object in view the following set of war-time specifications has been prepared. Although they are designated "war-time," it will be seen that the required degree of accuracy has been maintained, whilst unnecessarily restrictive dimensions have been relaxed. The general result is a co-ordination of the requirements of the manufacturer and of the user. The Sub-Committee is confident that the thermometers will be as satisfactory as the previous instruments, and, moreover, considers that improvements have been introduced in many cases. Advantage has been taken of this opportunity to include specifications for some thermometers in general use, but not previously specified. Two thermometers appearing in previous I.P. specifications have now been withdrawn, as it is felt that other specified thermometers adequately replace them. These are the "I.P. Cut-back Viscosity" and the "I.P. Setting Point" thermometers, replaced by the "Redwood Cup Low" and the "Cloud and Pour" thermometers, respectively.

The complete list of war-time thermometer specifications is printed below, prior to publication in the next edition of "Standard Methods," so that the new standard thermometers can come into general use immediately. Thermometers conforming to the 1935 and 1942 specifications may still be used, but thermometers should be manufactured in future to conform to the new specifications until further notice.

WAR-TIME STANDARD THERMOMETERS

INTRODUCTION

These specifications cover glass thermometers graduated in Centigrade or Fahrenheit degrees and specified in Institute of Petroleum Methods. The thermometers shall conform to the general requirements and to the special requirements listed below.

However, thermometers with different identification marks but which conform to all the other requirements of the specification are permissible.

Purchasers should not accept thermometers as complying with these specifications because they are marked with I.P. markings, as these inscriptions are identification marks and do not necessarily constitute a guarantee.

Purchasers must satisfy themselves that the permissible scale errors, given in the table of special requirements, have not been exceeded.

It is essential that thermometers be marked with a material resistant to the action of hot petroleum products.

GENERAL REQUIREMENTS

Type.—Mercury in glass, solid stem except where otherwise stated. Gas filled.

Stem.—The stem shall be made of lead-glass or other suitable glass. Enamel back.

Bulb.—The bulb shall be made of a suitable thermometric glass approved by the National Physical Laboratory. At present these glasses include:

	Identification mark.	Approved for temperatures up to
Normal glass made by James Powell & Sons, Ltd.	Single blue stripe.	350° C.*
Normal glass made by Frank Tomey & Co., Ltd.	Two blue stripes.	350° C.*
Corning boro-silicate made by Corning Glass Co.	—	450° C.
Normal glass, Dial, made by Plowden & Thomson	Double blue stripes.	350° C.

* May be used up to 400° C. if a careful examination of the zero is made periodically.

Expansion and Contraction Chamber.—No contraction chamber shall be above the immersion line, and no enlargement of the bore shall be within 10 mm. of the immersion line or of any part of the scale.

Graduation and Figuring.—The graduation lines shall be clearly etched, and of uniform thickness, not exceeding 0·15 mm.† The lines shall all be at right angles to the axis of the thermometer. When the thermometer is viewed from the front and in a vertical

† In the case of the "V.I." thermometers the graduation lines shall not exceed 0·10 mm. in thickness.

position, the lines shall all finish on a line parallel to the axis on the left-hand side. Certain of the graduation lines shall be extended on the right-hand side, but the shortest graduations shall not extend across the bore. When the diameter of the tube permits, the figures shall be upright when the thermometer is viewed from the front and is in a vertical position (except in the case of the " Congealing Point " thermometer), and should preferably be placed so that they would be intersected by the line to which they refer if it were extended.

Marking.—In addition to the special markings given in the table, each thermometer shall be marked with an identification number and the maker's or vendor's name or trade mark. Each thermometer shall also be marked with the immersion at which it is to be used—*e.g.*, " Full immersion," " 11 cm. immersion," etc. Thermometers intended to be used at partial immersion should have a line etched round the stem to indicate the depth of immersion.

Permanency of Range.—Thermometers must be suitably annealed, and thermometers which are normally used at temperatures of 200° C. and upwards and certain other specified thermometers shall be subjected to a test for permanency of range. This test shall consist of heating the finished thermometer for 24 hours at the highest temperature shown on the scale, and then checking the rise, if any, after the thermometer has been allowed to cool and stabilize for 4 or 5 days.

The permanency of range test shall be applied to the following:

" I.P. 4W. Crude Oil Dist."
" I.P. 5W. Low Dist."
" I.P. 6W. High Dist."
" I.P. 7W. Loss on Heating."
" I.P. 16W. P.M. High."
" I.P. 22W. A.M. Oxidation."
" I.P. 28W. Cleveland."
" I.P. 32W. V.I. 210° F."
" I.P. 37W. Sludge."
" I.P. 41W. Drop Point High."

Verification.—For referee purposes, only thermometers which have been tested at the National Physical Laboratory shall be used, and the appropriate corrections shall be applied. Satisfactory thermometers will be marked with the N.P.L. monogram and year of test and a certificate of corrections issued.

It is desirable that thermometers shall be re-tested at intervals not exceeding five years.

Scale Errors.—The scale error maxima, given in the table of special requirements, are intended as a guide to manufacturers, who are expected to guarantee that they are not exceeded.

Special Note.

Existent stocks of thermometers, conforming to the I.P. 1935 and 1942 specifications, may be used. New thermometers shall, however, conform to the present requirements.

**

SPECIAL REQUIREMENTS.

Name and Special Marking.	"I.P. 1W. Cloud and Pour."	"I.P. 2W. Low Cloud and Pour."	"I.P. 3W. Demulsification."	"I.P. 4W. Crude Oil Dist."	"I.P. 5W. Low Dist."	"I.P. 6W. High Dist."	"I.P. 7W. Loss on Heating."
Range	−36° F. to 120° F.	−70° F. to 70° F.	30° F. to 220° F.	−4° C. to 360° C.	−2° C. to 300° C.	−2° C. to 400° C.	150° C. to 175° C.
Graduation	2° F.	2° F.	1° F.	2° C.	1° C.	1° C.	1° C.
Immersion	108 mm.	76 mm.	Total	Total.	Total.	Total.	Total.
Dimensions: Overall length, ±10 mm.	250 mm.	260 mm.	—	310 mm.	380 mm.	420 mm.	180 mm.
Stem, diameter	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5–7 mm.
Bulb, shape	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.
,, length	10 mm. max.	10 mm. max.	—	10–20 mm.	8–16 mm.	8–16 mm.	10–20 mm.
,, diameter	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.
Length of graduated portion	60–90 mm.	60–90 mm.	Not less than 170 mm.	150–180 mm.	210–250 mm.	300–360 mm.	60–90 mm.
Distance, bottom of bulb to	−36° F. Not less than 120 mm.	−70° F. Not less than 120 mm.	— —	0° C. Not less than 95 mm.	0° C. 100–110 mm.	0° C. 25–40 mm.	150° C. 45–65 mm.
Longer lines at each	10° F. from −30° F.	10° F.	5° F.	10° C.	5° C.	5° C.	5° C.
Figured at each	20° F. from −20° F.	20° F. from −60° F.	10° F.	20° C.	10° C.	10° C.	5° C.
Expansion chamber	To allow heating to 212° F.	To allow heating to 140° F.	Required.	Required.	Required.	Required.	Required.
Top finish	Plain.	Plain.	Ring.	Ring.	Ring.	Ring.	Ring.
Scale error not to exceed plus or minus	2° F.	2° F.	1° F.	2° C.	0·5° C. to 150° C. 1° C. above 150° C.	1° C. to 300° C. 2° C. above 300° C.	0·5° C.
See notes	—	1 and 2	—	—	—	—	3

1. To be filled with toluene or other suitable liquid coloured red with permanent dye; the filling above the liquid to be gas under pressure.
2. A tropical type marked "I.P. 2W. Low Cloud and Pour Tropical," shall have an expansion chamber to allow heating to 180° F.
3. The lines at 162° C. and 164° C. should be approximately twice as thick as those at other points and should be extended to the left-hand side.

SPECIAL REQUIREMENTS—*continued.*

1. To be filled with toluene or other suitable liquid coloured red with permanent dye; the filling above the liquid to be gas under pressure.
2. A tropical type marked "I.P. 2W. Low Cloud and Pour Tropical," shall have an expansion chamber to allow heating to 180° F.
3. The lines at 162° C. and 164° C. should be approximately twice as thick as those at other points and should be extended to the left-hand side.

SPECIAL REQUIREMENTS—*continued.*

Name and Special Marking.	"I.P. 8W. Redwood Cup Low."	"I.P. 9W. Redwood Cup Medium."	"I.P. 10W. Redwood Cup High."	"I.P. 11W. Redwood Bath Low."	"I.P. 12W. Redwood Bath Medium."	"I.P. 13W. Redwood Bath High."	"I.P. 14W. Cold Test."
Range	30° F. to 110° F.	100° F. to 180° F.	170° F. to 250° F.	30° F. to 110° F.	100° F. to 180° F.	170° F. to 250° F.	−80° C. to 20° C.
Graduation	0·5° F.	0·5° F.	0·5° F.	1° F.	1° F.	1° F.	0·5° C.
Immersion	65 mm.	65 mm.	65 mm.	65 mm.	65 mm.	65 mm.	Total.
Dimensions: Overall length, ±10 mm.	340 mm.	340 mm.	340 mm.	—	—	—	300 mm.
Stem, diameter	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.
Bulb, shape	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.
,, length	10–16 mm.	10–16 mm.	10–16 mm.	20 mm. max.	20 mm. max.	20 mm. max.	8–16 mm.
,, diameter	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.
Length of graduated portion	150–190 mm.	150–190 mm.	150–190 mm.	120 mm. min.	120 mm. min.	120 mm. min.	170–210 mm.
Distance, bottom of bulb to	30° F. 115 mm. min.	100° F. 115 mm. min.	170° F. 115 mm. min.	30° F. 100 mm. min.	100° F. 100 mm. min.	170° F. 100 mm. min.	0° C. 220 mm. max.
Longer lines at each	1° F. and 5° F.	1° F. and 5° F.	1° F. and 5° F.	5° F.	5° F.	5° F.	1° C. and 5° C.
Figured at each	5° F.	5° F.	5° F.	10° F.	10° F.	10° F.	5° C.
Expansion chamber	To allow heating to 212° F.		Required.	To allow heating to 212° F.		Required.	To allow heating to 45° C.
Top finish	Ring.	Ring.	Ring.	Ring.	Ring.	Ring.	Plain or ring.
Scale error not to exceed plus or minus	0·5° F.	0·5° F.	1·0° F.	1·0° F.	1·0° F.	1·0° F.	1° C.
See notes	1	1	1	2	2	2	3 and 4

1. A swelling (the bottom of which shall be 100–105 mm. from the bottom of the bulb) shall be provided.
2. A swelling need not be provided.
3. To be filled with toluene or other suitable liquid coloured red with permanent dye; the filling above the liquid to be gas under pressure.
4. A tropical type marked "I.P. 14W. Cold Test Tropical," shall have an expansion chamber to allow heating to 80° C.

SPECIAL REQUIREMENTS—*continued.*

Name and Special Marking.	"I.P. 15W. P.M. Low."	"I.P. 16W. P.M. High."	"I.P. 17W. Wax Setting Point."	"I.P. 18W. Congealing Point."	"I.P. 19W. Ring and Ball."	"I.P. 20W. Aniline Low."
Range	20° F. to 230° F.	200° F. to 700° F.	90° F. to 170° F.	68° F. to 212° F.	−2° C. to 160° C.	−36° C. to 42° C.
Graduation	1° F.	5° F.	0·2° F.	1·0° F.	1·0° C.	0·2° C.
Immersion	56 mm.	56 mm.	80 mm.	Total.	Total.	50 mm.
Dimensions: Overall length, ±10 mm.	280 mm.	280 mm.	380 mm.	245 mm.	300 mm.	410 mm.
Stem, diameter	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5–6 mm.	5·5–8·0 mm.	5·5–8·0 mm.
Bulb, shape	Spherical.	Spherical.	Cylindrical.	Ellipsoidal.	Cylindrical.	Cylindrical.
,, length			20 mm. max.	10–12 mm.	14 mm. max.	10–20 mm.
,, diameter	8 mm. max.	8 mm. max.	Not greater than stem.	4·5–6·0 mm.	Not greater than stem.	Not greater than stem.
Length of graduated portion	150–180 mm.	150–180 mm.	200–240 mm.	Not less than 150 mm.	160–200 mm.	230–270 mm.
Distance, bottom of bulb to	20° F. 70 mm. min.	200° F. 70 mm. min.	90° F. 100–120 mm.	68° F. Not less than 50 mm.	0° C. 70–90 mm.	−36° C. 100–130 mm.
Longer lines at each	5° F.	10° F. and 50° F.	1° F.	5° F.	5° C.	1° C.
Figured at each	10° F.	50° F.	5° F.	10° F.	10° C.	2° C.
Expansion chamber	Required.	Required.	To allow heating to 212° F.	Required.	Required.	To allow heating to 100° C.
Top finish	Ring.	Ring.	Plain.	Ring.	Ring.	Ring.
Scale error not to exceed plus or minus	1° F.	5° F. to 500° F. 10° F. above 500° F.	0·4° F.	1° F.	1° C.	0·2° C.
See notes	1	1	2 and 3	4 and 5	—	6

1. A swelling to be provided to ensure the location of the thermometer collar at the correct point (see I.P.–34/42, Section 2 (d)).
2. Top of contraction chamber to be not more than 41 mm. from the bottom of the bulb.
3. The thermometer shall be standardized for the following temperatures of the emergent mercury column:

Thermometer Reading.	Average Temperature of Emergent Mercury Column.
90° to 130° F.	70° F. ± 10° F.
130° to 170° F.	80° F. ± 10° F.

4. See Fig. 1.
5. Figures to be horizontal in line with the long axis of thermometer.
6. The thermometer shall be standardized over the entire range for an average temperature of the emergent mercury column of 20° C. ± 5° C.

SPECIAL REQUIREMENTS—*continued.*

Name and Special Marking.	"I.P. 23W. Abel Flash."	"I.P. 24W. Abel Oil Cup."	"Abel Oil Cup Fahrenheit."	"Abel Water Bath Fahrenheit."
Range	60° F. to 200° F.	60° F. to 200° F.	60° F. to 200° F.	60° F. to 200° F.
Graduation	1° F.	1° F.	1° F.	1° F.
Immersion	56 mm.	56 mm.	56 mm.	56 mm.
Dimensions: Overall length, ±10 mm.	280 mm.	280 mm.	280 mm.	280 mm.
Stem, diameter	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.
Bulb, shape	Spherical.	Spherical.	Spherical.	Spherical.
,, length				
,, diameter	8 mm. max.	8 mm. max.	8 mm. max.	8 mm. max.
Length of graduated portion	150–180 mm.	150–180 mm.	150–180 mm.	150–180 mm.
Distance, bottom of bulb to	60° F. 70 mm. min.	60° F. 70 mm. min.	60° F. 70 mm. min.	60° F. 70 mm. min.
Longer lines at each	5° F.	5° F.	5° F.	5° F.
Figured at each	10° F.	10° F.	10° F.	10° F.
Expansion chamber	Required.	Required.	Required.	Required.
Top finish	Ring.	Ring.	Ring.	Ring.
Scale error not to exceed plus or minus	1° F.	1° F.	1° F.	1° F.
See notes	1	1	1	1

1. A swelling to be provided to ensure the location of the thermometer collar at the correct point (see I.P.–34/42, Section 2 (d)).

90° to 130° F.
130° to 170° F.

70° F. ± 10° F.
80° F. ± 10° F.

4. See Fig. 1.

5. Figures to be horizontal in line with the long axis of thermometer.

6. The thermometer shall be standardized over the entire range for an average temperature of the emergent mercury column of 20° C. ± 5° C.

SPECIAL REQUIREMENTS—*continued.*

Name and Special Marking.	"I.P. 21W. Aniline High."	"I.P. 22W. A.M. Oxidation."	"I.P. 23W. Reid V.P."	"I.P. 24W. Gum."	"Abel Oil Cup Fahrenheit."	"Abel Water Bath Fahrenheit."
Range	25° C. to 105° C.	195° C. to 205° C.	94° F. to 108° F.	204° F. to 218° F.	50° F. to 150° F.	90° F. to 190° F.
Graduation	0·2° C.	0·1° C.	0·2° F.	0·2° F.	1° F.	1° F.
Immersion	80 mm.	100 mm.	Total.	Total.	—	—
Dimensions: Overall length, ±10 mm.	410 mm.	260 mm.	260 mm.	260 mm.	9 in. approx.	9 in. approx.
Stem, diameter	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	5·5–8·0 mm.	0·24–0·28 in.	0·24–0·28 in.
Bulb, shape	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Spherical.	Cylindrical.
,, length	10–30 mm.	25–35 mm.	25–35 mm.	25–35 mm.	—	0·8 in. approx.
,, diameter	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	0·35 ± 0·05 in.	Not greater than stem.
Length of graduated portion	230–270 mm.	70–110 mm.	60–90 mm.	60–90 mm.	At least 4·75 in.	At least 3·55 in.
Distance, bottom of bulb to	25° C. 100–120 mm.	200° C. 150–180 mm.	94° F. 130–150 mm.	204° F. 130–150 mm.	50° F. 2·75–3·15 in.	90° F. 3·95–4·35 in.
Longer lines at each	1° C.	0·5° C.	1° F.	1° F.	5° F. and 10° F.	5° F. and 10° F.
Figured at each	2° C.	1° C.	2° F.	2° F.	10° F.	10° F.
Expansion chamber	Required.	Required.	To allow heating to 212° F.	Required.	Required.	Required.
Top finish	Ring.	Ring.	Ring.	Ring.	Plain.	Plain.
Scale error not to exceed plus or minus	0·3° C.	0·3° C.	0·2° F.	0·4° F.	0·3° F.	1·0° F.
See notes	1	—	—	—	2	2

1. The thermometer shall be standardized for the following temperatures of the emergent mercury column:

Thermometer Reading.	Average Temperature of Emergent Mercury Column.
Up to 35° C.	20° C. ± 5° C.
35° C. to 65° C.	25° C. ± 5° C.
Above 65° C.	30° C. ± 5° C.

2. A swelling is to be provided in the stem to ensure that the thermometer shall be fixed in its brass collar so that the distance from the top of the collar to the bottom of the bulb is 2·40 ± 0·05 in. for the "oil-cup" and 3·5 ± 0·1 in. for the "water-bath" thermometer. The brass collar shall be of the following dimensions: Outside diameter, push fit in socket. Thickness of tube, 22 I.W.G. Thickness of flange, 0·1 ± 0·001 in. A model apparatus is deposited in the Standards Department of the Board of Trade.

SPECIAL REQUIREMENTS—*continued.*

Name and Special Marking.	"I.P. 25W. C.F.R. Low."	"I.P. 26W C.F.R. Med."	"I.P. 27W. C.F.R. High."	"I.P. 28W. Cleveland."	"I.P. 29W. V.I. 68° F."	"I.P. 30W. V.I. 77° F."
Range	80° F. to 220° F.	180° F. to 320° F.	280° F. to 400° F.	20° F. to 760° F.	(31·5° F. to 32·5° F.) 66·5° F. to 71·5° F.	(31·5° F. to 32·5° F.) 74·0° F. to 80·0° F.
Graduation	2° F.	2° F.	2° F.	5° F.	0·05° F.	0·05° F.
Immersion	50 mm.	50 mm.	50 mm.	25 mm.	Total.	Total.
Dimensions: Overall length	160 mm. ± 5 mm.	160 mm. ± 5 mm.	160 mm. ± 5 mm.	320 mm. ± 10 mm.	280 mm. ± 10 mm.	280 mm. ± 10 mm.
Stem, diameter	5·5–6·5 mm.	5·5–6·5 mm.	5·5–6·5 mm.	5·5–8·0 mm.	5·0–8·0 mm.	5·0–8·0 mm.
Bulb, shape	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.
,, length	10 mm. max.	10 mm. max.	10 mm. max.	13 mm. max.	20–35 mm.	20–35 mm.
,, diameter	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.
Length of graduated portion	70–90 mm.	70–90 mm.	70–90 mm.	200–240 mm.	60–90 mm.	60–90 mm.
Distance, bottom of bulb to	80° F. Not less than 60 mm.	180° F. Not less than 60 mm.	280° F. Not less than 60 mm.	20° F. 40–60 mm.	68° F. 170–210 mm.	77° F. 170–210 mm.
Longer lines at each	10° F.	10° F.	10° F.	10° F.	0·1° F. and 0·5° F.	0·1° F. and 0·5° F.
Figured at each	20° F.	20° F.	20° F.	20° F.	1° F.	1° F.
Expansion chamber	Required.	Required.	Required.	Required.	To allow heating to 212° F.	
Top finish	Plain.	Plain.	Plain.	Ring.	Ring.	Ring.
Scale error not to exceed plus or minus	2° F.	2° F.	2° F.	10° F.	0·1° F. at 68° F. and 70° F.	0·1° F. at 77° F.
See notes	1 and 2	1 and 2	1 and 2	—	3, 4 and 5	3, 4 and 5

1. Diameter of swelling on stem, if required, to be not less than 8 mm. and not more than 9 mm. Distance bottom of bulb to centre of swelling shall be 40 mm. ± 1 mm.
2. A contraction chamber shall also be provided and the distance from the bottom of the bulb to the top of the contraction chamber shall be as short as possible but shall in no case exceed 25 mm.
3. The graduation lines for these thermometers shall not exceed 0·10 mm. in thickness.
4. Top of contraction chamber to be not more than 120 mm. from bottom of bulb.
5. The range 31·5° F. to 32·5° F. is for checking purposes only.

SPECIAL REQUIREMENTS—*continued.*

4. Top of contraction chamber to be not more than 120 mm. from bottom of bulb.
5. The range 31·5° F. to 32·5° F. is for checking purposes only.

SPECIAL REQUIREMENTS—*continued.*

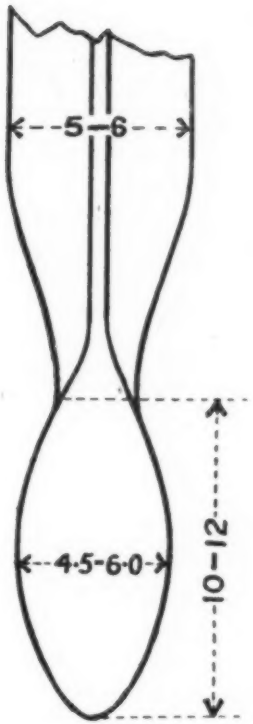
Name and Special Marking.	" I.P. 31W. V.I. 100° F."	" I.P. 32W. V.I. 210° F."	" I.P. 33W. Kin. Vis. 32° F."	" I.P. 34W. Kin. Vis. 130° F."	" I.P. 35W. Kin. Vis. 140° F."	" I.P. 36W. Kin. Vis. 200° F."
Range	(31·5° F. to 32·5° F.) 97·5° F. to 102·5° F.	(31·5° F. to 32·5° F.) 208·5° F to 213·5°F.	29·0° F. to 35·0° F.	127·0° F. to 133·0° F.	137·0° F. to 143·0° F.	197·0° F. to 203·0° F.
Graduation	0·05° F.	0·05° F.	0·1° F.	0·1° F.	0·1° F.	0·1° F.
Immersion	Total.	Total.	Total.	Total.	Total.	Total.
Dimensions : Overall length ± 10 mm.	280 mm.	280 mm.	280 mm.	280 mm.	280 mm.	280 mm.
Stem, diameter	5·0–8·0 mm.	5·0–8·0 mm.	5·0–8·0 mm.	5·0–8·0 mm.	5·0–8·0 mm.	5·0–8·0 mm.
Bulb, shape	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.
,, length	20–35 mm.	20–35 mm.	20–35 mm.	20–35 mm.	20–35 mm.	20–35 mm.
,, diameter	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.	Not greater than stem.
Length of graduated portion	60–90 mm.	60–90 mm.	50–80 mm.	50–80 mm.	50–80 mm.	50–80 mm.
Distance, bottom of bulb to	100° F. 170–210 mm.	210° F. 170–210 mm.	32° F. 170–210 mm.	130° F. 170–210 mm.	140° F. 170–210 mm.	200° F. 170–210 mm.
Longer lines at each	0·1° F. and 0·5° F.	0·1° F. and 0·5° F.	0·5° F.	0·5° F.	0·5° F.	0·5° F.
Figured at each	1° F.	1° F.	1° F.	1° F.	1° F.	1° F.
Expansion chamber	To allow heating to 212° F.	Required.	To allow heating to 212° F.	To allow heating to 212° F.	To allow heating to 212° F.	Required.
Top finish	Ring.	Ring.	Ring.	Ring.	Ring.	Ring.
Scale error not to exceed plus or minus	0·1° F. at 100° F.	0·1° F. at 210° F. and 212° F.	0·2° F. at 32° F.	0·2° F. at 130° F.	0·2° F. at 140° F.	0·2° F. at 200° F.
See notes	1, 2 and 3	1, 2 and 3	—	4	4	4

1. The graduation lines for these thermometers shall not exceed 0·10 mm. in thickness.
2. Top of contraction chamber to be not more than 120 mm. from bottom of bulb.
3. The range 31·5° F. to 32·5° F. is for checking purposes only.
4. The contraction chamber to be 80–120 mm. from bottom of bulb.

SPECIAL REQUIREMENTS—*concluded.*

Name and Special Marking.	"I.P. 37W. Sludge."	"I.P. 38W. Pen. and Duct."	"I.P. 39W. Sp. Gr."	"I.P. 40W. Drop Point Low."	"I.P. 41W. Drop Point High."	"I.P. 42W. Breaking Point."
Range	144·0° C. to 156·0° C.	23·0° C. to 27·0° C.	30° F. to 100° F.	20° C. to 120° C.	100° C. to 230° C.	−40° C. to 30° C.
Graduation	0·2° C.	0·1° C.	0·2° F.	1° C.	1° C.	0·5° C.
Immersion	100 mm.	Total.	Total.	100 mm.	100 mm.	250 mm.
Dimensions: Overall length, ±10 mm.	270 mm.	260 mm.	440 mm.	250 mm.	250 mm.	370 mm.
Stem, diameter	5·0–8·0 mm.	5·0–8·0 mm. Lens front.	5·5 to 8·0 mm.	4·5 to 6·0 mm.	4·5 to 6·0 mm.	6·0 to 7·0 mm.
Bulb, shape	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.	Cylindrical.
,, length	10–25 mm.	20–40 mm.	15–25 mm.	6·0 mm. max.	6·0 mm. max.	10–16 mm.
,, diameter	Not greater than stem.	Not greater than stem.	Not greater than stem.	3·35–3·65 mm.	3·35–3·65 mm.	Not greater than stem.
Length of graduated portion	50–80 mm.	40–60 mm.	300–350 mm.	Not less than 100 mm.	Not less than 100 mm.	Not less than 60 mm.
Distance, bottom of bulb to	150° C. 170–210 mm.	25° C. 170–210 mm.	30° F. 40–60 mm.	20° C. Not less than 100 mm.	100° C. Not less than 100 mm.	
Longer lines at each	1° C.	0·5° C.	1·0° F.	5° C.	5° C.	1° C. and 5° C.
Figured at each	2° C.	1° C.	2·0° F.	10° C.	10° C.	5° C.
Expansion chamber	Required.	To allow heating to 100° C.	To allow heating to 212° F.	Required.	Required.	To allow heating to 80° C.
Top finish	Ring.	Ring.	Ring.	Ring.	Ring.	Ring.
Scale error not to exceed plus or minus	0·2° C. at 150° C.	0·1° C. at 25° C.	0·2° F.	1° C.	1° C.	0·5° C.
See notes	—	1	—	2, 3 and 4	2, 3 and 4	5

1. 5 to 8 mm. diameter to be interpreted as "not go" or "go" through rings of these dimensions.
2. For dimensions and location of sleeve, see I.P.–31/44, Section 2.
3. The surfaces of the thermometer and of the sleeve shall be roughened or indented to ensure an effective key between the cement and the surfaces.
4. The stem immediately above the bulb shall be reduced in diameter to be approximately equal to, but not smaller than, that of the bulb over a length of approximately 2 cm.
5. A swelling 8–10 mm. in diameter, the bottom of which shall be 250 mm. ± 2 mm. from the bottom of the bulb, shall be provided to ensure that the thermometer is used at the correct immersion and to support it in the inner tube of the apparatus.



The section at right angles to the perpendicular
to be circular everywhere.
All dimensions in mm.

FIG. 1.
BULB OF "CONGEALING POINT" THERMOMETER.

PRINTED IN GREAT BRITAIN BY
RICHARD CLAY AND COMPANY, LTD.,
BUNGAY, SUFFOLK.

INSTITUTE NOTES.

DECEMBER, 1943.

STANLOW BRANCH

The Committee of the Stanlow Branch has made tentative arrangements for the following meetings during the 1943–44 Session. Branch members will be notified direct, in advance, of the date, place and time of all meetings, and in this connection it is requested that any Member of the Institute resident in the Stanlow area should acquaint the Honorary Secretary of his wish to be registered as a member of the Stanlow Branch.

Provisional Syllabus.

Jan. 16, 1944. Social event and Brains Trust.
Feb. 16, 1944. Fuels for the C.I. Engine. Mr. F. L. Garton.
Mar. 14, 1944. Synthetic detergents and wetting agents. Mr. A. N. Holmes
Apr. 12, 1944. Petroleum and plastics. Dr. H. Barron.

The officers and members of committee for the forthcoming Session are :—

Chairman : J. S. Parker.
Members of Committee : V. Biske.
G. Davidson.
F. L. Garton.
J. Grant.
J. G. Hancock.

J. C. WOOD-MALLOCK,
Hon. Secretary and Treasurer.

NEW MEMBERS.

The following elections have been made by the Council in accordance with the By-Laws, Sect. IV, Para. 7.

Elections are subject to confirmation in accordance with the By-Laws, Sect. IV, Paras. 9 and 10.

Transfer to Fellow.

DRAPER, Philip.

As Members

DUBSEK, Alan James.
HUDSON, Cyril Henry.
MILES, James Douglas.
TETLOW, Norman.
WALLACH, Herbert L.

As Associate Members.

COWELL, Leonard Herbert.
HOLMES, Harold Richard.
LINDSAY, James.
MCCARTHY, William C. F.
MAUCHAN, Alexander C.
RUFFELL, Henry A.

Transfer to Associate Member.

JU, Ting Yih.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

CAMPION, James Douglas, Chemist, Anglo-Egyptian Oilfields Ltd. (*H. Toone ; P. G. Higgs.*)

GARDINER, Michael Allan Rawson, Student, Birmingham University. (*F. H. Garner.*)

GLYDE, Harold Stanley, Research Engineer, Ricardo & Co., Ltd. (*H. R. Ricardo ; C. H. Barton.*)

HARDY, Alfred Cecil, Naval Architect. (*S. J. M. Auld ; C. W. Wood.*)

HARLAND, William Stanley, Chemist, Royal Dutch Petroleum Co.(*A. McCulloch.*)

HARRIES, Gwynne Hughes, Research Chemist, Manchester Oil Refinery Ltd. (*E. J. Dunstan ; P. M. Griffiths.*)

HEBBERD, Richard Stanley Hurcum, Student, Birmingham University. (*F. H. Garner.*)

HUTCHINSON, Fred, Analytical Chemist, Shell Refining & Marketing Co. (*G. Davidson ; J. Grant.*)

KING, George, Senior Installation Supervisor, Petroleum Board. (*G. Davidson ; J. Grant.*)

LEIGHTON, William Alan, Student, Birmingham University. (*F. H. Garner.*)

LOXLEY, Michael John, Student, Birmingham University. (*F. H. Garner.*)

PETTY, Donald Stuart, Student, Birmingham University. (*F. H. Garner.*)

POLSON, Hector Fraser, Senior Technical Adviser, Scottish Oils & Shell-Mex Ltd. (*A. E. Hope ; H. W. Clark.*)

SHEARN, Ronald Bertram, Student, Birmingham University. (*F. H. Garner.*)

SMITH, Jack Kitson, Student, Birmingham University. (*F. H. Garner.*)

STOUT, Kenneth Rowland, Student, Birmingham University. (*F. H. Garner.*)

TIGG, Thomas Hugh, Chemist, Anglo-Egyptian Oilfields Ltd. (*H. Toone ; P. G. Higgs*).

WHISTON, John Reginald Harvey, Professor of Chemistry and Metallurgy, Military College of Science. (*A. E. Dunstan ; D. A. Howes.*)

Applications for Transfer.

CUDE, Arthur Leslie, Assistant Chemist. (*T. G. Hunter ; A. H. Nissan.*)

KIERNAN, Herbert Stephen, Works Chemist and Production Manager. *J. E. M. Haslam ; E. A. Evans.*)

MOORE, Philip Harold, Chemical Engineer. (*J. Barrett ; H. Moore.*)

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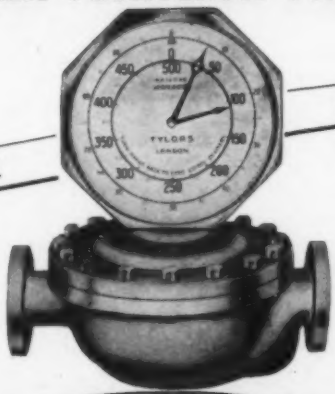

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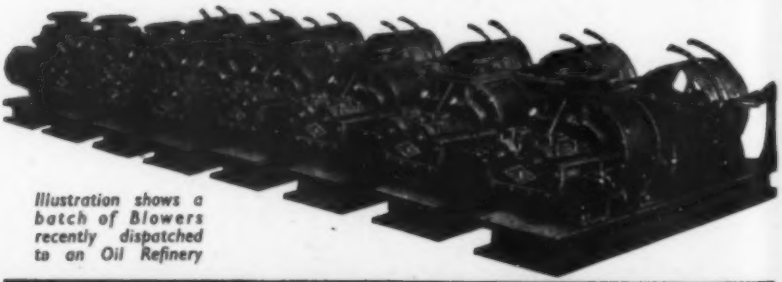

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INSTITUTE NOTES.

JANUARY, 1943.

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The following have applied for admission to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

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The names of candidates' proposers and seconders are given in parenthesis.

BASS, Ernest Leon, Mechanical Engineer, Asiatic Petroleum Co., Ltd. (*John A. Oriel; R. I. Lewis.*)

CHARLESWORTH, Percy Allen, Research Chemist, Moore & Barrett. (*James Barrett; Harold Moore.*)

CROSS, David Thomas, Patent Agent, Standard Oil Co. (*Hugh C. Tett; F. H. Garner.*)

CONTRIBUTIONS TO THE *JOURNAL*.

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BENEVOLENT FUND.

The attention of members is directed to the urgent need for building up a reasonable reserve in the Benevolent Fund in support of the many cases that will undoubtedly arise at the termination of hostilities. Contributions may be made by means of Bankers Orders which are circulated with the Annual Report, or may be sent direct to the Secretary of the Institute at the Imperial College of Science and Technology, Prince Consort Road, London, S.W.7.

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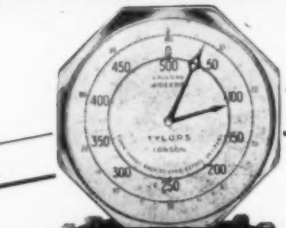

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INSTITUTE NOTES.

FEBRUARY, 1943.

STAFF.

Mr. F. H. Coe, who was appointed Acting Secretary of the Institute in July last, has now been confirmed in his appointment as Secretary.

CANDIDATES FOR ADMISSION.

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CHARLESWORTH, Percy Allan, Research Chemist, Moore & Barrett. (*James Barrett; Harold Moore.*)

COE, Frederick Henry, Secretary, Baku Consolidated Oilfields. (*A. Frank Dabell; Richard R. Tweed.*)

CROSS, David Thomas, Patent Agent, Standard Oil Development Co. (*Hugh C. Tett; Prof. F. H. Garner.*)

FRANKEL, Paul Herzberg, Managing Director, Raven Oil Co., Ltd. (*Cecil W. Wood; Dr. F. Kind.*)

OSTLER, Frank Allan, Research Chemist, Arthur Brown & Co., Ltd. (*C. B. Wingfield; J. F. M. Webb.*)

CONTRIBUTIONS TO THE *JOURNAL*.

In view of the fact that the orbit of the Institute has now been widely extended, it was decided at a recent meeting of the Publication Committee to invite contributions to the *Journal* from members, not only on purely scientific and technical topics, but on those matters that might be of general interest. The Publication Committee will be pleased to accept such contributions from members.

STUDENTS' SECTION, BIRMINGHAM UNIVERSITY.

A meeting was held in the Oil Department, Birmingham University, on 1st December, 1942. Fourth-Year Students presented papers based on their Theses, half an hour being allowed for reading and quarter of an hour for discussion.

The following papers were read in the morning :—

" The Design of High Pressure Reactors," by J. Tadayon.

" Disease and its Relation to the Oil Industry," by M. L. Fellowes.

The following papers were read in the afternoon :—

" The Hydrodynamics of Jets," by A. W. Pearce.

" Modern Well Completion," by A. G. T. Weaver.

" Prime Movers in Rotary Drilling and Mechanical Pumping," by D. A. Hartley.

Voting by secret ballot resulted in A. W. Pearce winning the First Prize of £2, and M. L. Fellowes winning the Second Prize of £1. A. W. Winward won the prize for the best contribution to the discussion.

New Officers were elected as follows :—

Chairman	G. K. Ashforth.
3rd-Year representative	A. W. Winward.
2nd-Year representative	B. A. Faulkner.

The meeting concluded with tea in the Museum of the Oil Department.

NOTE.

It will be of interest to the many members of the Institute who for various reasons are unable to visit the premises or attend meetings, to know of the many activities being carried on to an even greater extent than formerly.

Regular monthly meetings are being held during the current session, attendances at which are beyond expectations, and the discussions give proof of the keen interest taken in submitted papers.

There are now no less than thirty-seven active committees and panels, with a total membership of upwards of one hundred and thirty, meeting frequently, and much valuable work is being carried out.

ARTHUR W. EASTLAKE.
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Joint Honorary Secretaries.

INSTITUTE NOTES.

MARCH, 1943.

CANDIDATES FOR ADMISSION.

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The names of candidates' proposers and seconders are given in parentheses.

ERNSTE, Jan Willem, Manager, B.P.M. (*John A. Oriel ; R. I. Lewis.*)

GREENBERG, Leander, Research Chemist. (*Dr. A. H. Nissan ; C. E. Wood.*) (Application for transfer from Student to Associate Member.)

NOBLE, George, Assistant Manager, Agwi Petroleum Corporation, Ltd. (*H. D. Demoulins ; Prof. F. H. Garner.*)

ROSENFELD, Ludwig, Research Engineer, Institution of Automobile Engineers. (*C. G. Williams ; E. A. Evans.*)

CONTRIBUTIONS TO THE *JOURNAL*.

In view of the fact that the orbit of the Institute has now been widely extended, it was decided at a recent meeting of the Publication Committee to invite contributions to the *Journal* from members, not only on purely scientific and technical topics, but on those matters that might be of general interest. The Editors are particularly anxious to have papers dealing with exploration, so that many members of the Institute who are quite unacquainted with the amazing pioneering hardships and difficulties which geologists, geophysicists, and surveyors have had to contend with since the inception of the industry may hear of what their fellow-members have achieved. These papers should be confined to information of general interest, and should be illustrated by photographs if possible.

STANLOW BRANCH.

Since the formation of the Stanlow Branch in 1940, nineteen meetings have been held, and the current session has seen the following papers read :—

"Aero Engine Performance in relation to Fuels." By Dr. C. G. Williams.

"Butadiene and Synthetic Rubber Developments." By K. L. Butcher.

"Cracking and Related Processes—Developments in 1942." By J. C. Wood-Mallock.

"Varieties of Asphaltic Bitumens." By W. W. Goulston.

In addition, an informal social function held on 19th January last was attended by forty-one members and nine guests from H.M. Forces and local industry. On this occasion a petroleum "Brains Trust" was formed from amongst the members and their unrehearsed answers to the not always serious questions submitted during the evening were much appreciated. The remaining meetings scheduled for the 1942–43 Session are on 24th March, when Dr. Ter Meulen will read the paper on "Solvent Refining of Lubricating Oils," recently given to the Institute of Chemical Engineers, and on 28th April when the Annual General Meeting will be held.

The membership of the Branch has, after reaching a peak in 1941–42 at 135, declined somewhat owing to National Service calls, and stands at the moment at 121, of whom 36 are members of the parent Institute. The attendance at meetings averages about 40.

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INSTITUTE NOTES.

APRIL, 1943.

CANDIDATES FOR ADMISSION.

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The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

GOSSLING, Percy William L., Research Chemist, W. B. Dick & Co., Ltd. (*A. J. Sear; A. C. Michie.*)

MOORE, Harold, Consulting Technologist. (*Dr. A. E. Dunstan; C. Dalley.*) (Application for transfer from Member to Fellow.)

HALLAM, Thomas A., Research Chemist, Shell Refining and Marketing Co., Ltd. (*P. M. Griffith; G. D. Hall.*)

FORTHCOMING MEETINGS.

Meetings have been arranged for the 29th April, 27th May, and the 24th June, and will be held at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2, on those days at 5.0 p.m.

On the 29th April, Professor V. C. Illing will give a paper on **"Education and the Petroleum Industry."**

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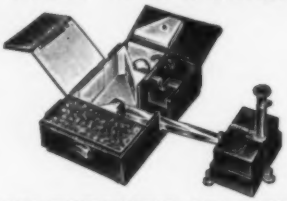

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MAY, 1943.

CANDIDATES FOR ADMISSION.

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The names of candidates' proposers and seconders are given in parentheses.

BAILEY, Clifford Henry, Mechanical Engineer, Iraq Petroleum Co., Ltd. (*R. V. Browne ; A. J. Perks.*)

CHAPMAN, Stanley Frank, Deputy Maintenance Manager, Middlesex County Council. (*R. F. A. Baldwin ; L. F. Moore.*)

FINNIGAN, Peter Francis, Engineer, Petroleum Board. (*S. J. W. Pleeth ; F. Tipler.*)

FISHER, John William, Designer-Draughtsman, " Shell " Refining & Marketing Co., Ltd. (*E. Le Q. Herbert ; Dr. C. G. Williams.*)

IVEY, Terence, Manager & Group Transport Officer, Middlesex County Council. (*R. F. A. Baldwin ; L. F. Moore.*)

MACKINDER, Richard, Senior Asst. in Laboratory, " Shell " Refining & Marketing Co. (*P. M. Griffiths ; J. D. Hall.*)

MULHERN, John, Regional Technical Officer, Ministry of Fuel & Power. (*G. B. Pound ; Dr. A. J. V. Underwood.*)

RUMBLE, Victor Horace. Research Chemist, Anglo-Iranian Oil Co. (*Dr. A. E. Dunstan ; Dr. D. A. Howes.*)

SHARP, William Robert, Engineer, Petroleum Board. (*F. Tipler ; F. E. Chilvers.*)

WANDYCZ, Damian, Acting Chief of Office of Energetics, Polish Ministry of Industry, Commerce & Shipping. (*Dr. J. A. Kronsten ; Cecil W. Wood.*)

WINDEBANK, Charles Stanley, Chemical Engineer, International Association (P.T.), Ltd. (*H. C. Tett ; W. E. J. Broom.*)

FORTHCOMING MEETINGS.

On 24th June, Dr. H. Ter Meulen will read a paper on " Solvent Refining of Lubricating Oils."

LUNCHEON.

A luncheon will be held at the Connaught Rooms, Great Queen Street, Kingsway, W.C.2, on Wednesday, June 23rd, 1943.

Further details will be issued in due course.

ANNUAL GENERAL MEETING.

It is hoped to hold the Annual General Meeting on the above date prior to the luncheon.

ARTHUR W. EASTLAKE,
ASHLEY CARTER,
Joint Honorary Secretaries.

INSTITUTE NOTES.

JUNE, 1943.

PROFESSOR VLADIMIR N. IPATIEFF.

The Chicago Chapter of the American Institute of Chemists held a banquet on 20th November, 1942, in honour of Professor Vladimir N. Ipatieff on the occasion of his seventy-fifth birthday. Papers were read by Dr. Gustav Egloff on "Ipatieff's Influence on Industry," by Mr. Frank C. Whitmore, of the Pennsylvania State College, on "Ipatieff, his Influence on World Chemistry," and by Professor Ward V. Evans, of North-western University, on "Vladimir N. Ipatieff."

In the course of his paper Dr. Egloff said that Professor Ipatieff was not only celebrating his seventy-fifth birthday, but also fifty years in the chemical profession, during which time he had been responsible for discoveries and developments which had profoundly affected world chemistry and industry. He had organized the chemical industry in Russia during the Great War, and later was given a similar assignment by the Soviet Government, eventually becoming the head of a Committee that was appointed by the Academy of Sciences to re-establish and expand its contacts with foreign scientific bodies. Twelve years ago he had come to the United States and joined the Universal Oil Products Company, and since then he had accomplished his greatest work.

Among the many discoveries made by the Professor were the establishment of the fundamental structure of isoprene, the basic hydrocarbon of rubber; the production of butadiene from ethyl alcohol by catalytic treatment, upon which process the synthetic rubber industry of the U.S.S.R. was built; the preparation of ethylene from ethyl alcohol by catalytic dehydration; and the production of ketones and aldehydes from alcohols, using brass as a catalyst.

In the early stages of his career, Professor Ipatieff, who was then an artilleryman, studied the rates of combustion of various nitroglycerine explosives at pressures up to 4500 atmospheres, and it was this type of research which opened the way to the discovery of the field of commercial high-pressure chemical reactions such as the hydrogenation and destructive hydrogenation of organic compounds.

Another achievement of the first magnitude was the discovery of a solid phosphoric acid catalyst which polymerized olefins in cracked

gases to motor fuel of high octane rating. Prior to this discovery, the by-product gases from cracking operations to produce motor fuel were burned under boilers or stills, or vented into the air.

One of the Professor's crowning achievements was the alkylation of paraffins with olefins, a reaction which had hitherto been thought impossible, but which was now the groundwork for the production of 100 octane aviation spirit.

Professor Ipatieff's impact on other industries had shown itself in the development of a new chemical industry, new metallurgy, new instrumentation, and a host of other materials which supply new chemicals and equipment necessary to carry out processes which he had given as a heritage to the present generation and to generations yet to come.

STUDENTS' SECTION, BIRMINGHAM UNIVERSITY.

A Meeting of the Section was held on 21st January, 1943, in the Oil Department, and a very interesting talk was given by Mr. C. A. P. Southwell. The subject was "Production from a Sandstone Reservoir," and the talk dealt largely with the problem of secondary recovery.

A joint meeting of the Section and the Birmingham Section of the Institute of Chemists was held at the University, Edmund Street, Birmingham, on Monday, 8th March, 1943. Dr. A. E. Dunstan introduced a film, "A.I.O.C. Operations in Persia," and gave a short talk, illustrated by slides, dealing with the development of Petroleum Products, and their future.

An extensive section dealing with the geology, production, transport, refining, and by-products of oil, was organized by the members of the Section, for the Mining and Fuel Production Exhibition given by the Birmingham University Mining Society, at the beginning of March. The Exhibition was held in connection with the Fuel Economy Drive, and had the full co-operation of the city authorities and the Ministry of Fuel and Power. Students were in attendance throughout the week to explain the exhibits, which included many models, diagrams, full-sized equipment, photographs, and synthetics. Synthetic rubber was made on the spot. Over 24,000 passed through the two large marquees, which also contained exhibits dealing with Metal Mining, Coal Mining, and Coal Utilization.

HONOURS.

Major G. M. Barrett, R.A., Fellow of the Institute, has been awarded the M.B.E. for "devotion to duty and service of exceptional merit."

PAPERS FOR MEETINGS.

The Publication Committee is now preparing the programme for meetings to be held from September next onwards, and will welcome the submission of papers for presentation. They should be forwarded to the Chairman, Publication Committee, Institute of Petroleum, c/o Imperial College of Science and Technology, Prince Consort Road, London, S.W.7.

CANDIDATES FOR ADMISSION.

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The names of candidates' proposers and seconders are given in parentheses.

BLOWERS, Frank Frederick, Laboratory Assistant, Anglo-American Oil Co., Ltd. (*S. J. W. Pleeth ; M. E. W. Miller.*)

GOODWIN, Alfred Frank, Works Manager, Silvertown Lubricants, Ltd. (*L. O. Maskell ; E. A. Evans.*)

JACOBS, Thomas Henry, Laboratory Assistant, Petroleum Board. (*S. J. W. Pleeth ; M. E. W. Miller.*)

LOW, Peter, Installation Manager, Petroleum Board. (*Dr. E. B. Evans ; C. Chilvers.*)

MATTHEWS, Charles, Technical Representative, Matthew Wells & Co. (*V. H. Stott ; A. E. Dunstan.*)

MEULEN, Hubert Ter, Technologist (B.P.M.). (*I. G. Nixon ; G. Baars.*)

MOON, Sidney E. A., Deputy Chief Chemist, Silvertown Lubricants, Ltd. (*L. O. Maskell ; J. L. Taylor.*)

PIOTROWSKI, Waclaw de Junosza, Adviser on Fuel, Polish Ministry. (*Dr. R. C. Fisher ; D. H. Carter.*)

ROSE, Geoffrey Thomas, Chemical Assistant, Petroleum Board. (*S. J. W. Pleeth ; M. E. W. Miller.*)

*

STEPHENS, Francis Edward, Chemical Assistant, Shell-Mex & B.P. Ltd. (*S. J. W. Pleeth ; M. E. W. Miller.*)

APPLICATIONS FOR TRANSFER FROM MEMBER TO FELLOW.

CHAPMAN. Stanley Herbert, Technical Assistant. (*A. E. Chambers ; C. Dalley.*)

FORSTER, Leslie, C.B.E., Engineer. (*T. L. Bonstow ; J. G. Biermann.*)

PLEETH, Samuel J. W., Chemist. (*Dr. E. B. Evans ; J. Cantor.*)

ARTHUR W. EASTLAKE,
ASHLEY CARTER,
Joint Honorary Secretaries.

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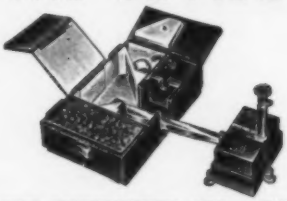

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INSTITUTE NOTES.

JULY, 1943.

PRESIDENT.

Mr. Christopher Dalley, M.I.E.E., has been re-elected President of the Institute for the year 1943–44.

VICE-PRESIDENTS.

The Council has elected the following to be Vice-Presidents of the Institute for the Session 1943–44 :—

Mr. ASHLEY CARTER.
Mr. G. G. COXON.
Professor F. H. GARNER.
Mr. A. C. HARTLEY.
Professor V. C. ILLING.
Mr. J. A. ORIEL.

HONOURS.

Among the Birthday Honours conferred by the King are the following :—

C.B.E.

JOHN MELLOR PATTINSON (Associate Member).

O.B.E.

Professor F. H. GARNER, Ph.D., M.Sc., M.I.Chem.E., F.I.C.

PERSONAL.

Dr. GUSTAV EGLOFF, Director of Research of Universal Oil Products Company, is the 1943 recipient of the Columbia University Medal of Merit, which is awarded annually to an outstanding scientific or technological leader in industry.

CONTRIBUTIONS TO THE *JOURNAL*.

Contributions from members of the Institute will be welcomed with a view to their inclusion in the *Journal*, either in the form of papers which have been submitted to meetings of branches, or original contributions on subjects of interest to the general body of members.

ELECTIONS.

The attention of members is directed to their prerogative of nominating members for election to the Council of the Institute. Nominations must be signed by ten Fellows, Members, or Associate Members, including the proposer.

CANDIDATES FOR ADMISSION.

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The names of candidates' proposers and seconders are given in parentheses.

ADAMS, Ivan Gifford Barr, Joint Managing Director, James Light & Son, Ltd. (*F. C. Baker ; H. E. Kessen.*)

BAINES, Archibald Ernest Walter, Technical Engineer, Wm. Neill & Son (St. Helens), Ltd. (*Harold Moore ; H. E. Charlton.*)

BRICE, Frank, Asst. Chief Clerk, Stanlow Refinery. (*G. Davidson ; J. G. Hancock.*)

DONE, Albert, Analyst, Shell Refining & Marketing Co., Ltd. (*G. Davidson ; T. T. Davies.*)

FENTON, Bert Vincent, Chemist, The Attock Oil Co., Ltd. (*T. T. McCreath ; J. G. A. Jeffrey.*)

HADLOW, Reginald Edward Eric, Installation Manager, Bristol Channel Oil Wharves, Ltd. (*S. J. W. Pleeth ; M. E. W. Miller.*)

MILLER, Andrew Craig, Research Engineer, Humber Limited. (*P. Draper ; H. Fossett.*)

PATON, Harold, Manchester Oil Refinery, Ltd. (*E. J. Dunstan ; H. E. Charlton.*)

SMITH, Reginald William, Petroleum Chemist, Shell-Mex & B.P., Ltd. (*S. J. W. Pleeth.*)

TAYLOR, John Ralph Carlisle, Petroleum Officer, Defence Dept., India.

WILSON, Peter Henry, Engineer, Bamag Limited. (*Dr. F. Kind ; H. E. Charlton.*)

APPLICATION FOR TRANSFER.

MASKELL, Laurence Ormes (Ass. Member). (*S. J. M. Auld ; E. A. Evans.*)

ARTHUR W. EASTLAKE.
ASHLEY CARTER.
Joint Honorary Secretaries.

INSTITUTE NOTES.

AUGUST, 1943.

NEW MEMBERS.

The following elections have been made by the Council in accordance with the By-Laws, Sect. IV, para. 7.

Elections are subject to confirmation in accordance with the By-Laws, Sect. IV, paras. 9 and 10.

As Fellows.

BASS, Ernest Leon
ERNSTE, Jan Willem
MEULEN, Hubert Ter
MITCHELL, John
RIDLER, Kenneth Edgar William
ROSENFELD, Ludwig
SCHNABEL, Fred
WANDYCZ, Damian
WINDEBANK, Charles Stanley

Transferred to Fellows.

CHAPMAN, Stanley Herbert
FLEMING, Peter
FLETCHER, Robert Mason
FORSTER, Walter Leslie
MOORE, Harold
OCKENDEN, Maurice Albion
PLEETH, Samuel John Warren

As Members.

BAILEY, Clifford Henry
BATTYE, John
BISHOP, Henry John
CHAPMAN, George Norman
CHRISTIAN, John Bell
COE, Frederick Henry
CROSS, David Thomas
FINNIGAN, Peter Francis
FRANKEL, Paul Herzberg
GOSSLING, Percy William
HUMPHREY, Kenneth Ernest
HURRELL, William Mark
MATTHEWS, Charles
MULHERN, John
NOBLE, George
PEPPER, Albert Cecil
RICHARDS, Alan Roy
RUMBLE, Victor Horace
SHARP, William Robert
WIGZELL, Albert Orsborn
WILDING, John Sherley

As Associate Members.

ANDERSON, Ronald Turnbull
BLOWERS, Frank Frederick
BUTCHER, Kenneth Leopold
CHAPMAN, Stanley Frank
CHARLESWORTH, Percy Allan
CURRAN, Bernard Reginald
FISHER, John William
HALLAM, Thomas Alfred
HARKESS, John Mackay
IVEY, Terence
JACOBS, Thomas Henry
JAMIESON, John
KING, Stanley
MACKINDER, Richard
MCEWEN, George Charles
MOON, Sydney Edward Allen
NEWBALD, Walter Noel Selby
PATMAN, Frederick John
POCOCK, Neville Richard
ROY, Clarke
SIMPKIN, Francis Ronald
STEPHENS, Francis Edward

Transferred to Associate Members.

GOTTESMAN, Manfred
GRUNBERG, Leander

As Students.

BADDELEY, Alan Rowland W.
BOWES, Emmerson
FAULKNER, Brian Alex
HUGGINS, Leonard John
MARTYN, John Robert
SHELDON, James Hervey
SUGDEN, Walter

CANDIDATES FOR ADMISSION.

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COWELL, Leonard Herbert, Assistant Chemist, Petroleum Board. (*Edward L. Gent ; T. C. R. Baker.*)

DUSSEK, Alan James, Managing Director, Dussek Bitumen & Taroleum, Ltd. (*E. R. Hatt ; Prof. F. H. Garner.*)

MCCARTHY, William Charles Frederick, Buying Manager, Sterns, Ltd. (*A. L. Read ; Walter Kay.*)

TETLOW, Norman, Mechanical Engineer, Mather & Platt, Ltd. (*H. A. Hammick ; E. A. Satchell.*)

WALLACH, Herbert Lewis, Director, Sterns, Ltd. (*A. L. Read ; Walter Kay.*)

Application for Transfer.

DRAPER, Philip, Mechanical Engineer. (*John A. Oriel ; J. S. Jackson.*)

FORTHCOMING MEETING.

On the 30th September, 1943, Dr. P. H. Frankel will read a paper on " Oil Transport and Post-War Reconstruction in Europe."

ROYAL INSTITUTE OF CHEMISTRY.

Members will have noted with interest and gratification that the Institute of Chemistry has been honoured by the addition of " Royal " to its title.

ARTHUR W. EASTLAKE,
ASHLEY CARTER.
Joint Honorary Secretaries.

INSTITUTE NOTES.

SEPTEMBER, 1943.

HONOURS.

Lt.-Commander J. R. Smellie, R.N.V.R., has been awarded the Distinguished Service Cross for gallantry at sea and devotion to duty.

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HOLMES, Harold Richard, Installation Supervisor, "Shell" Refining and Marketing Co., Ltd. (*G. Davidson ; E. Stokoe.*)

HUDSON, Cyril Henry, Sales Director, Sterns, Ltd. (*A. L. Read ; A. M. Nicholas.*)

JU, Ting Yih, Chemical Engineer, Universal Trading Corpn. (*Application for Transfer to Associate Member.*)

LINDSAY, James, Superintendent, Anglo-American Oil Co., Ltd. (*J. E. Jenkin ; F. Tipler.*)

LOWE, Robert, Assistant Regional Manager, Petroleum Board. (*V. M. Farrant ; E. J. Dunstan.*)

MAUCHAN, Alexander Callander, Chemist, Petroleum Board. (*C. Chilvers ; E. B. Evans.*)

MILES, James Douglas, Supervisor, Petroleum Board. (*W. B. Heaton ; H. C. W. Johnston.*)

RUFFELL, Henry Alfred, Chemist, Ministry of Supply. (*A. J. Featherstone ; H. Linnard.*)

STANDARD METHODS FOR TESTING PETROLEUM AND ITS PRODUCTS.

The Fifth Edition of the above book is now in active course of preparation, and it is hoped to be able to publish it early in 1944. Publication date and price will be announced later.

MEMBERS OF THE STANDARDIZATION COMMITTEE, SUB-COMMITTEES, AND PANELS.

The following list of members of the Standardization Committee and its Sub-Committees and Panels is published for the information of members of the Institute.

Standardization Committee.

F. H. Garner (*Chairman*)
W. E. J. Broom
G. H. Coxon
A. E. Dunstan
E. A. Evans
E. B. Evans
D. A. Howes
H. Hyams
V. C. Illing
J. S. Jackson
C. D. Lawrence
J. A. Oriel
D. S. Paul
J. E. Ramsbottom
E. R. Redgrove
K. E. W. Ridler
A. R. Stark
W. J. Wilson

Sub-Committee No. 1.—Measurement and Sampling.

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T. L. Evans
F. H. Garner
A. W. Higson
M. H. Hoffert
W. F. Jelffs
P. Kerr
J. Kewley
A. Osborn
E. Stokoe
G. D. Thacker
F. B. Thole
W. H. Thomas
F. Tipler

I. *Calibration of Tanks Panel.*

F. Tipler (*Chairman*)
A. W. Higson
W. F. Jelffs
P. Kerr
E. Stokoe

II. *Measurement of Oil Depths Panel.*

E. Stokoe (*Chairman*)
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III. *Sampling Panel.*

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E. B. Evans
J. E. Byles
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IV. *Temperature Measurement Panel.*

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E. Stokoe
W. H. Thomas

V. *Gravity Measurement Panel.*

E. B. Evans (*Chairman*)
T. L. Evans
A. Osborn
W. H. Thomas

VI. *Units of Measurement, Calculations, and Tables Panel.*

P. Kerr (*Chairman*)
E. B. Evans

Sub-Committee No. 2.—Crude Oil.

G. H. Coxon (*Chairman*)
B. C. Allibone
Dr. E. J. Boorman
C. Dalley
A. G. Forbes
R. I. Lewis
G. W. Lepper
H. E. L. Pracy
A. R. Stark
W. H. Thomas

Sub-Committee No. 3.—Liquefied Petroleum Gases Gasoline, Kerosine, and Light Distillates.

Dr. E. B. Evans (*Chairman*)
F. S. Aumonier
L. J. Bellamy
E. R. H. Davies
A. E. Dunstan
F. H. Garner
T. K. Hanson
S. R. Hills
W. H. Hoffert
C. D. Lawrence
J. Mason
G. R. Nixon
A. Osborn
D. S. Paul
A. R. Stark
T. M. Taylor
W. H. Thomas
S. A. W. Thompson
W. A. Woodrow

Burning Test Panel.

S. R. Hills (*Chairman*)
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G. R. Nixon
A. Osborn
D. S. Paul
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Gum Stability Panel.

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Colour Panel.

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R. Sefton
T. M. Taylor
W. A. Woodrow

Liquefied Gases Panel.

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N. Aston
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J. H. D. Hooper
N. E. Jones

Sub-Committee No. 4.—Gas, Diesel, and Fuel Oil.

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G. H. H. Brown
C. D. Lawrence
J. S. Jackson
J. Parrish
D. S. Paul
G. H. Smith
W. H. Thomas
S. R. Pethrick
A. T. Wilford
W. A. Woodrow

Diesel Index-Cetane Number Correlation Panel.

W. E. J. Broom (*Chairman*)
J. Parrish
W. H. Thomas

Asphaltenes in Crude Oil Panel.

J. Parrish
W. H. Thomas
W. A. Woodrow

*

Stability of Fuel Oils Panel.

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A. T. Wilford

Sub-Committee No. 5.—Engine Tests.

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E. A. Evans
E. B. Evans
E. Giffen
L. J. le Mesurier
J. A. Oriel
D. S. Paul
K. E. W. Ridler
R. Stansfield
A. T. Wilford
C. G. Williams
C. S. Windebank
J. G. Withers

Knock Rating of Aviation Fuel Panel.

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P. Draper
T. K. Hanson
J. Mason
C. H. Sprake
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C. G. Williams

Ignition Quality of Diesel Fuel Panel.

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S. J. Davies
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D. S. Paul
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J. G. Withers

Knock Rating of Motor Fuel Panel.

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N. L. Anfilogoff
L. W. Barnard
C. H. Barton
P. Draper
H. Fossett
E. Giffen
T. K. Hanson
J. H. Pitchford
C. Sprake

Mechancial Tests of Lubricants Panel.

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R. Stansfield
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Sub-Committee No. 6.—Lubricants.

E. A. Evans (*Chairman*)
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S. C. Atkinson
S. J. M. Auld
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W. E. J. Broom
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K. E. W. Ridler
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E. G. Ellis
F. J. S. Hall
J. Hill
C. D. Lawrence
L. O. Maskell
W. Pethrick
M. W. Webber
H. L. West
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INSTITUTE NOTES.

OCTOBER, 1943.

ELECTION TO COUNCIL

The attention of Members is drawn to the following extracts from the By-Laws governing election to the Council of the Institute :

(*a*) The Council of the Institute shall be chosen from the Fellows and Members only.

(*b*) Every Fellow, Member, and Associate Member of the Institute may send in writing to the Council the name of a Fellow or Member whom he desires to recommend for election to the Council. This nomination must be signed by at least nine other Fellows, Members or Associate Members and delivered to the Secretary not later than 30th day of November in any year. No Fellow, Member, or Associate Member may sign more than one Nomination Paper in any one year.

NEW MEMBERS.

The following elections have been made by the Council in accordance with the By-Laws, Sect. IV, Para. 7.

Elections are subject to confirmation in accordance with the By-Laws, Sect. IV, Paras. 9 and 10.

As Fellow.

PIOTROWSKI, Waclaw de Jonosza.

Transferred to Fellow.

MASKELL, Laurence Ormes.

As Members.

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As Student.

ROSE, Geoffrey Thomas.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

LAWRENCE, Arthur Stuart Clark, Research Chemist, Imperial College of Science & Technology. (*D. Clayton : S. E. Bowrey.*)

MACLEAN, Alan Douglas, Chief Engineer, Trinidad Leaseholds, Ltd. (*C. Dalley ; F. H. Garner.*)

SEN GUPTA, Dr. N. C. Research Chemist, Burmah Oil Co. (*A. Reid ; E. T. Vachell.*)

SOULAL, Louis, Refinery Manager, Pressure Lubricants, Ltd. (*R. B. Hobson ; E. G. Grant*).

VAN DEN BERG, Gerard Bastiaan, Asst. Exploitation Engineer, Diadema Argentina S.A. de Petroleo. (*H. de Wilde ; R. B. B. Wrixon.*)

FORD, George William Wallace, Acting Manager, G. & B. Dept., Stemco, Ltd. *F. H. Garner ; F. Tipler.*)

INSTITUTE NOTES.

NOVEMBER, 1943.

ELECTION TO COUNCIL.

The attention of Members is drawn to the following extracts from the By-Laws governing election to the Council of the Institute:

(*a*) The Council of the Institute shall be chosen from the Fellows and Members only.

(*b*) Every Fellow, Member, and Associate Member of the Institute may send in writing to the Council the name of a Fellow or Member whom he desires to recommend for election to the Council. This nomination must be signed by at least nine other Fellows, Members, or Associate Members and delivered to the Secretary not later than 30th day of November in any year. No Fellow, Member, or Associate Member may sign more than one Nomination Paper in any one year.

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The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

ASTON, Leslie, Chemist, Esso European Laboratories. (*W. E. J. Broom; A. Osborn.*)

BARANY, George Martin, Student, Birmingham University. (*F. H. Garner.*)

CROOK, Lionel James, Production Operator, Anglo-Iranian Oil Co., Ltd. (*D. R. M. Pickard; H. S. Gibson.*)

HULL, Charles, Chemist, Shell Refining & Marketing Co., Ltd. (*G. Davidson; J. Grant.*)

KENZIE, Raphael George, Analytical Chemist, Shell Refining & Marketing Co., Ltd. (*G. Davidson; J. Grant.*)

REES, Vincent R. M., Assistant Works Chemist, John I. Thornycroft & Co., Ltd.

STEPHENSON, Maurice, Petroleum Production Engineer, Capt., R.E.M.E. (*R. B. B. Wrixon; H. de Wilde.*)

TRIPCONY, Donald Frank, Chemist, Esso European Laboratories. (*W. E. J. Broom; A. Osborn.*)

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MODERN PETROLEUM TECHNOLOGY.

Early in the New Year the Institute will publish a monograph entitled "Modern Petroleum Technology."

Whilst this volume will be authoritative, and will give an account of recent developments in petroleum science, it will, nevertheless, be simply worded and will be designed for the general reader. It is hoped it will be of particular value to many members who have no particular specialized knowledge of all the subjects described, but who are interested in the multiplicity of ways in which the Industry is developing.

The following will give members some idea of the scope of the new publication:

Section.	*General Editor.*
1. Exploration.	V. C. Illing.
2. Geology.	"
3. Geophysics.	"
4. Drilling and production.	C. A. P. Southwell and C. Dalley.
5. Pipe-lines, storage, and transport of crude oils.	C. Dalley.
6. Chemistry of petroleum.	F. B. Thole.
7. Refining:	J. A. Oriel.
(*a*) Light oils.	
(*b*) Heavy oils.	
8. Utilization:	F. H. Garner.
(*a*) Gasolines: (i) aviation.	E. L. Bass.
" (ii) motor.	E. B. Evans.
(*b*) Kerosenes, solvents, and white spirits.	F. N. Harrap and E. B. Evans.
(*c*) Gas oils.	H. Hollings.
(*d*) Fuel oils.	M. H. Hoffert.
(*e*) Oils for C.I. engines.	R. Stansfield.
(*f*) Lubricants and greases.	E. A. Evans.
(*g*) Waxes.	C. G. Gray.
(*h*) Bitumen.	J. S. Jackson.
(*i*) Carbon blacks.	W. H. Cadman.
(*j*) Insulating oils.	C. Chilvers.
9. Special products, solvents, plastics, rubber, explosives, soaps, etc.	A. E. Dunstan.
10. Transport and measurement.	C. Dalley, assisted by H. Hyams.
11. Economics and legislation.	C. Dalley.
12. Significance of tests.	J. S. Jackson.
13. Research and education.	F. H. Garner.

N.B.—It is hoped that as far as possible these contributions will be read before the Institute.

CHANGE OF ADDRESS.

On and after Tuesday, November 30th, 1943, communications should be addressed as follows :—

The Secretary,
The Institute of Petroleum,
26, Portland Place,
London, W.1.

Telephone: Langham 2250.
Telegraphic address: Instpetech Wesdo London.

FORTHCOMING EVENTS.

The next meeting of the Institute will be held in November, when Mr. H. L. West will read a paper entitled " Mechanical Testing of Extreme Pressure Lubricants."

Details of place and date of meeting will be notified to members in due course.

A joint meeting of the Institute with the Institution of Chemical Engineers will be held on December 14th, 1943, at 2.30 p.m. at Burlington House, Piccadilly, W.1 (Geological Society of London), when J. C. G. Boot will present a paper on " Petroleum as a Base Materials for Chemicals."

PETROLEUM FILMS BUREAU.

This Bureau issues a series of 35 mm. and 16 mm. sound and silent documentary and instructional films.

The films cover matters of general interest, such as Cargo for Ardrossan—a picture of the uses of oil in two highly contrasted communities—industrial Glasgow and the island of Islay; P.F.B. Cinemagazines; films illustrating how oil is produced and refined; and how motor-cars, etc., work.

The films may be borrowed free of charge by Service units, schools, technical colleges, educational and other organizations.

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INSTITUTE NOTES.

DECEMBER, 1943.

STANLOW BRANCH

The Committee of the Stanlow Branch has made tentative arrangements for the following meetings during the 1943–44 Session. Branch members will be notified direct, in advance, of the date, place and time of all meetings, and in this connection it is requested that any Member of the Institute resident in the Stanlow area should acquaint the Honorary Secretary of his wish to be registered as a member of the Stanlow Branch.

Provisional Syllabus.

Jan. 16, 1944. Social event and Brains Trust.
Feb. 16, 1944. Fuels for the C.I. Engine. Mr. F. L. Garton.
Mar. 14, 1944. Synthetic detergents and wetting agents. Mr. A. N. Holmes
Apr. 12, 1944. Petroleum and plastics. Dr. H. Barron.

The officers and members of committee for the forthcoming Session are :—

Chairman : J. S. Parker.
Members of Committee : V. Biske.
G. Davidson.
F. L. Garton.
J. Grant.
J. G. Hancock.

J. C. WOOD-MALLOCK,
Hon. Secretary and Treasurer.

NEW MEMBERS.

The following elections have been made by the Council in accordance with the By-Laws, Sect. IV, Para. 7.

Elections are subject to confirmation in accordance with the By-Laws, Sect. IV, Paras. 9 and 10.

Transfer to Fellow.

DRAPER, Philip.

As Members

DUSSEK, Alan James.
HUDSON, Cyril Henry.
MILES, James Douglas.
TETLOW, Norman.
WALLACH, Herbert L.

As Associate Members.

COWELL, Leonard Herbert.
HOLMES, Harold Richard.
LINDSAY, James.
McCARTHY, William C. F.
MAUCHAN, Alexander C.
RUFFELL, Henry A.

Transfer to Associate Member.

JU, Ting Yih.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

CAMPION, James Douglas, Chemist, Anglo-Egyptian Oilfields Ltd. (*H. Toone; P. G. Higgs.*)

GARDINER, Michael Allan Rawson, Student, Birmingham University. (*F. H. Garner.*)

GLYDE, Harold Stanley, Research Engineer, Ricardo & Co., Ltd. (*H. R. Ricardo; C. H. Barton.*)

HARDY, Alfred Cecil, Naval Architect. (*S. J. M. Auld; C. W. Wood.*)

HARLAND, William Stanley, Chemist, Royal Dutch Petroleum Co. (*A. McCulloch.*)

HARRIES, Gwynne Hughes, Research Chemist, Manchester Oil Refinery Ltd. (*E. J. Dunstan; P. M. Griffiths.*)

HEBBERD, Richard Stanley Hurcum, Student, Birmingham University. (*F. H. Garner.*)

HUTCHINSON, Fred, Analytical Chemist, Shell Refining & Marketing Co. (*G. Davidson; J. Grant.*)

KING, George, Senior Installation Supervisor, Petroleum Board. (*G. Davidson; J. Grant.*)

LEIGHTON, William Alan, Student, Birmingham University. (*F. H. Garner.*)

LOXLEY, Michael John, Student, Birmingham University. (*F. H. Garner.*)

PETTY, Donald Stuart, Student, Birmingham University. (*F. H. Garner.*)

POLSON, Hector Fraser, Senior Technical Adviser, Scottish Oils & Shell-Mex Ltd. (*A. E. Hope; H. W. Clark.*)

SHEARN, Ronald Bertram, Student, Birmingham University. (*F. H. Garner.*)

SMITH, Jack Kitson, Student, Birmingham University. (*F. H. Garner.*)

STOUT, Kenneth Rowland, Student, Birmingham University. (*F. H. Garner.*)

TIGG, Thomas Hugh, Chemist, Anglo-Egyptian Oilfields Ltd. (*H. Toone; P. G. Higgs*).

WHISTON, John Reginald Harvey, Professor of Chemistry and Metallurgy, Military College of Science. (*A. E. Dunstan; D. A. Howes.*)

Applications for Transfer.

CUDE, Arthur Leslie, Assistant Chemist. (*T. G. Hunter; A. H. Nissan.*)

KIERNAN, Herbert Stephen, Works Chemist and Production Manager. (*J. E. M. Haslam; E. A. Evans.*)

MOORE, Philip Harold, Chemical Engineer. (*J. Barrett; H. Moore.*)

BENEVOLENT FUND.

The attention of members is directed to the urgent need for building up reserves in the Benevolent Fund in support of the many cases that will undoubtedly arise at the termination of hostilities. Contributions may be sent to the Secretary of the Institute at 26, Portland Place, London, W.1.

ARTHUR W. EASTLAKE,
ASHLEY CARTER.
Joint Honorary Secretaries.

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WAR-TIME SPECIFICATION FOR I.P. PETROLEUM HYDROMETERS

A war-time specification for hydrometers has been prepared by the Standardization Committee in close collaboration with representatives of the manufacturers. The complete specification is printed below, prior to publication in the next edition of "Standard Methods," so that the new hydrometers can come into use immediately. Instruments conforming to the 1935 and 1942 specifications may still be used, but, in future, hydrometers manufactured in accordance with this war-time specification will be generally acceptable.

Under the restrictions imposed by war-time conditions manufacturers have experienced considerable difficulty in maintaining the required output, and it has frequently happened that time and material have been wasted as the result of instruments failing to meet stringent dimensional requirements which were not absolutely essential for the production of accurate hydrometers.

Wherever possible, the more stringent dimensional requirements have therefore been relaxed. Thus it will be seen that the obligatory specification includes the overall length, the length of scale, and the minimum length of stem below the bottom graduation, in addition to the accuracy clause. It is hoped that these war-time specifications will ensure that the best use is made of available material and labour, and it will be noted that while relaxing the dimensional requirements, it has been considered reasonable to stipulate rather greater accuracy than was demanded in the 1942 specifications.

The war-time specification aims at the highest standards in all essentials, while removing unduly restrictive dimensional requirements.

In connection with these war-time hydrometers, it will be appreciated that certification by the National Physical Laboratory will refer essentially to the accuracy of the instruments when used for petroleum products.

WAR-TIME I.P. PETROLEUM HYDROMETERS

Hydrometers shall conform to the dimensions given in Table I (p. 4) and to the following specification:—

(i) Hydrometers shall be made of glass, free from striæ or similar defects, and in particular the external surface of the stem shall be quite smooth. The glass shall be resistant to the action of chemicals and possess properties such as would render it suitable for use for thermometers; *i.e.*, it should have low thermal hysteresis and small secular change in volume.*

(ii) Hydrometers shall be thoroughly annealed before the scale is fixed.

(iii) For ranges above 0·700 the main bulb shall be cylindrical and/or torpedo-shaped (cylindrical for the greater part of its length and terminating in a cone), whilst for ranges below 0·700 it may be of any suitable shape. In all cases the cross-section of the stem shall be circular.

(iv) A thermometer shall not be part of the instrument.

(v) When mercury is used for loading, it is to be contained in a bulb at the base of the hydrometer, suitably sealed off with glass from the main bulb of the instrument.

(vi) In special hydrometers for use at higher temperatures than 100° F. any material used for sealing off the bulb or for holding loading material, such as shot, shall not soften below 212° F. (All hydrometers, after use at a higher temperature than 100° F., shall, as a matter of precaution, be allowed to drain and cool in a vertical position.)

(vii) The hydrometer shall be symmetrically constructed so that it floats with the stem vertical.

(viii) Paper of high quality shall be used for the scale, conforming with the requirements that it does not discolour at 212° F. with use and that all divisions may be sharply and accurately marked on it.

(ix) The scale shall be straight and without twist, and fixed with a cement which will not soften at the highest temperatures at which the hydrometer may be used.

(x) The scale of each hydrometer shall be graduated at each end for four divisions beyond its nominal range in Type 1, for two divisions in Type 2 and for one division in Type 3.

(xi) The graduation marks shall be made by fine straight lines, which lie in planes perpendicular to the axis of the hydrometer, so that the graduation marks are horizontal when the stem is vertical.

(xii) The subdivisions of the scale shall be without evident irregularities.

(xiii) Every 0·05 graduation mark shall be numbered without inserting either the decimal point or the figure 0 preceding the

* During the present war emergency, good quality glass other than of thermometric type may be used.

decimal point. The first one (or two) of the figures shall appear to the left of the scale and the last two to the right, *e.g.*, 6–50 and 7–00; 9–50 and 10–00. In addition, every intermediate 0·01 graduation mark shall be numbered, but abbreviated numbers shall be used for this purpose, *e.g.*, 60, 70, etc. These abbreviated numbers shall be printed on the right of the scale.

(xiv) The length of the graduation marks must be varied so that the exact reading corresponding to any mark can be easily identified. The shortest graduation marks must be at least 2 mm. in length.

(xv) A fine horizontal line shall be etched on the stem of the hydrometer Types 1 and 2, and this shall coincide with the horizontal part of a " pointing mark " which shall be ruled on the paper scale about 5 mm. above the highest graduation. This " pointing mark " shall be a short, fine line with a V at each end, thus:

(xvi) All hydrometers shall be graduated for reading correctly at the point of intersection of the level liquid surface with the stem.

(xvii) Hydrometers must be adjusted so that the reading on the scale in a liquid whose temperature is 60° F., which, in the case of Type 1 and Type 2 hydrometers, has the appropriate surface tension as given below, gives the specific gravity of the liquid at 60° F. relative to water at 60° F. (sp. gr. 60° F./60° F.).*

Hydrometer ranges.	Surface tension.
0·650 to 0·700 and 0·700 to 0·750	20 dynes/cm.
0·750 to 0·800 and 0·800 to 0·850	25 "
0·850 to 0·900 and 0·900 to 0·950	30 "
0·950 to 1·000, 1·000 to 1·050 and 1·050 to 1·100	35 "

The specific gravity 60° F./60° F. of water* shall be taken as 1·000 and the scale numbered accordingly.

(xviii) The maker shall mark each hydrometer with:

(*a*) " S $\frac{60° \text{ F.}}{60° \text{ F.}}$ at 60° F.," to indicate the basis of the scale.

(*b*) " Petroleum."

(*c*) " I.P. Type . . . " and an identification number.

(*d*) Vendor's or maker's name or mark.

(*e*) " Max. Temp. 212° F." or " Max. Temp. 100° F." according to whether the cementing material for fixing the loading is or is not suitable for the hydrometer to be used above 100° F.

* Specific gravity is defined as the ratio of the mass of a given volume of the product at a temperature t_1 to the mass of an equal volume of pure water at a temperature t_2. The masses are compared by weighings in air using brass weights and correcting to the corresponding weights *in vacuo*.

$$\text{Sp. Gr.} \frac{60° \text{ F.}}{60° \text{ F.}} = \frac{\text{Mass of a given volume of the substance at 60° F.}}{\text{Mass of an equal volume of water at 60° F.}}.$$

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0·800 to 0·850	1·050 to 1·100

When extreme accuracy is required, or in referee work, instruments certified by the National Physical Laboratory for accuracy shall be used. The corrections shown on the accompanying certificate shall be applied.

TABLE I.

Specified Dimensions and Tolerances.

	Type 1.	Type 2.	Type 3.
Length overall, mm. . . .	Max. 360 Min. 330	Max. 240 Min. 210	Max. 180 Min. 160
Number of sub-divisions in nominal scale	100	50	50
Length of nominal range of scale, mm.	Max. 185 Min. 155	Max. 115 Min. 90	Max. 65 Min. 50
Length of plain cylindrical stem below bottom graduation mark, mm.	Min. 5	Min. 5	Min. 5
Maximum permissible error at any point on the scale . . .	±0·0003	±0·0005	±0·001

The further dimensions shown in Table II are not to be regarded as obligatory, but merely as indicating the types of instruments desired.

TABLE II.

Recommended Dimensions and Tolerances.

	Type 1.	Type 2.	Type 3.
Diameter of bulb, mm. . .	Max. 40 Min. 35	Max. 25 Min. 20	Max. 20 Min. 16
Diameter of stem, mm. . .	Min. 5·0	Min. 4·3	Min. 4·0
Distance of top nominal graduation mark from top of stem, mm. .	Min. 25	Min. 15	Min. 10

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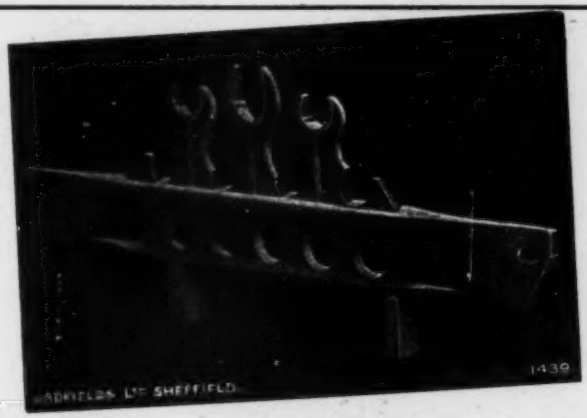

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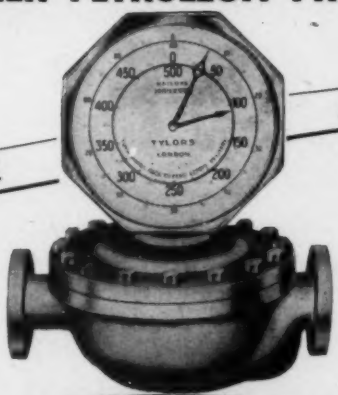

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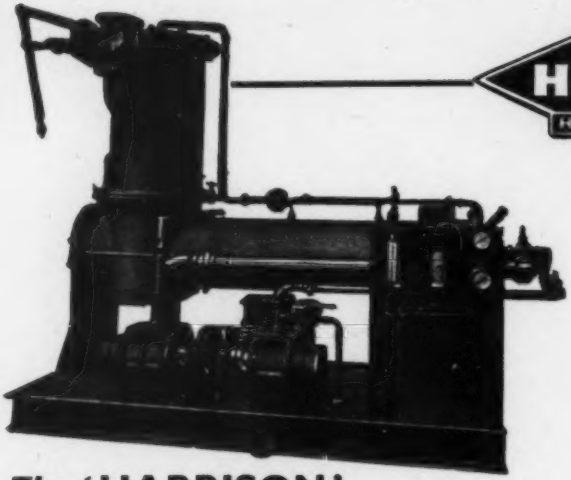

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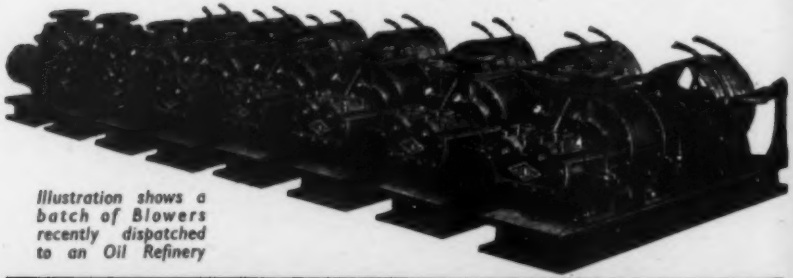

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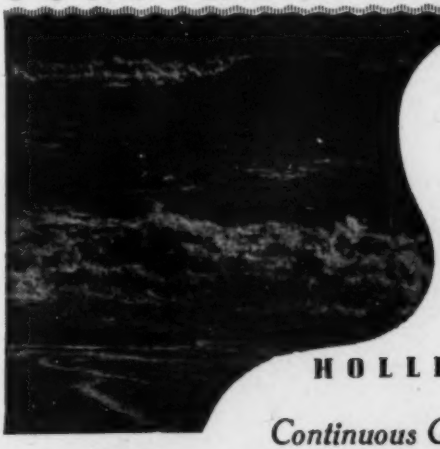

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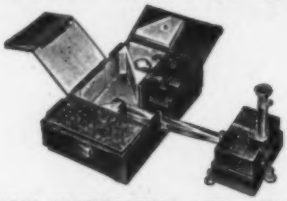

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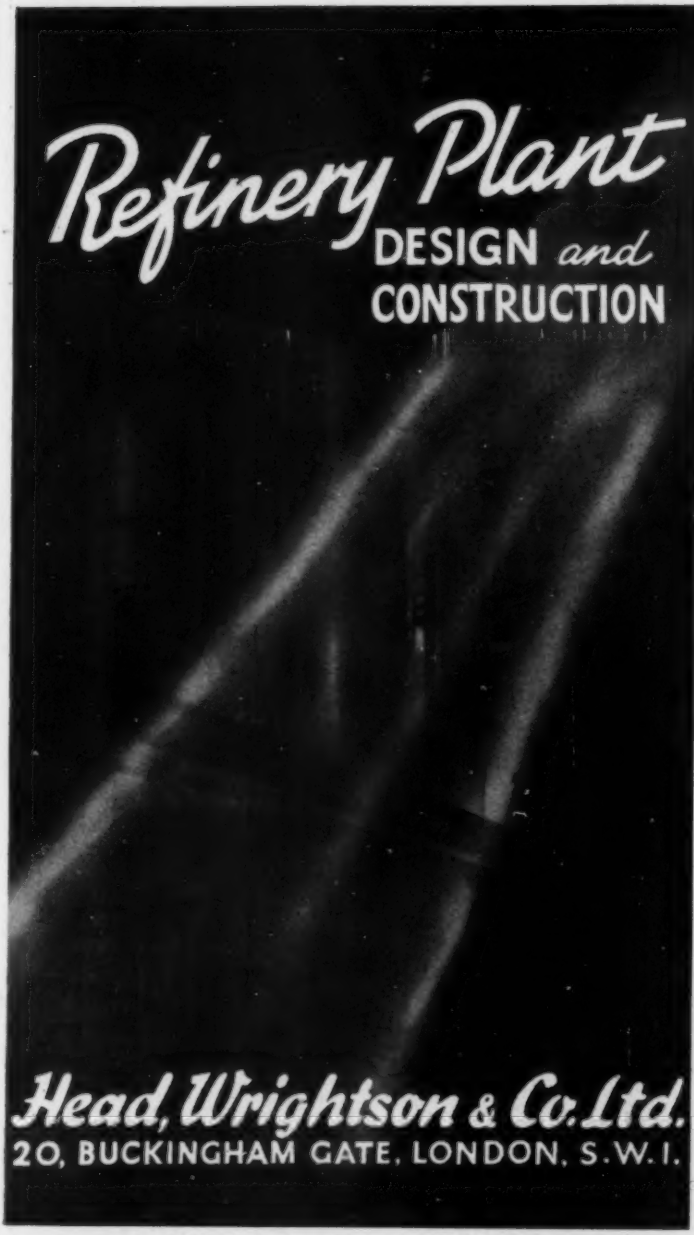
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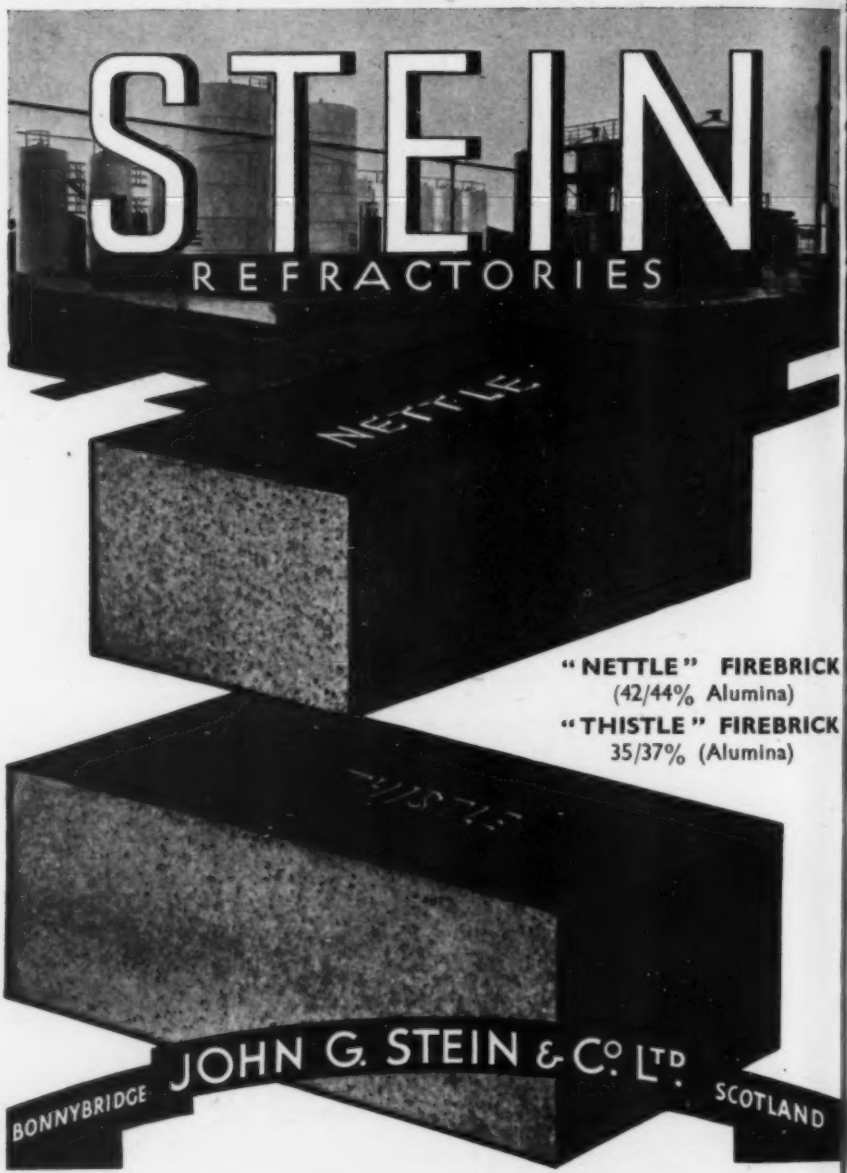

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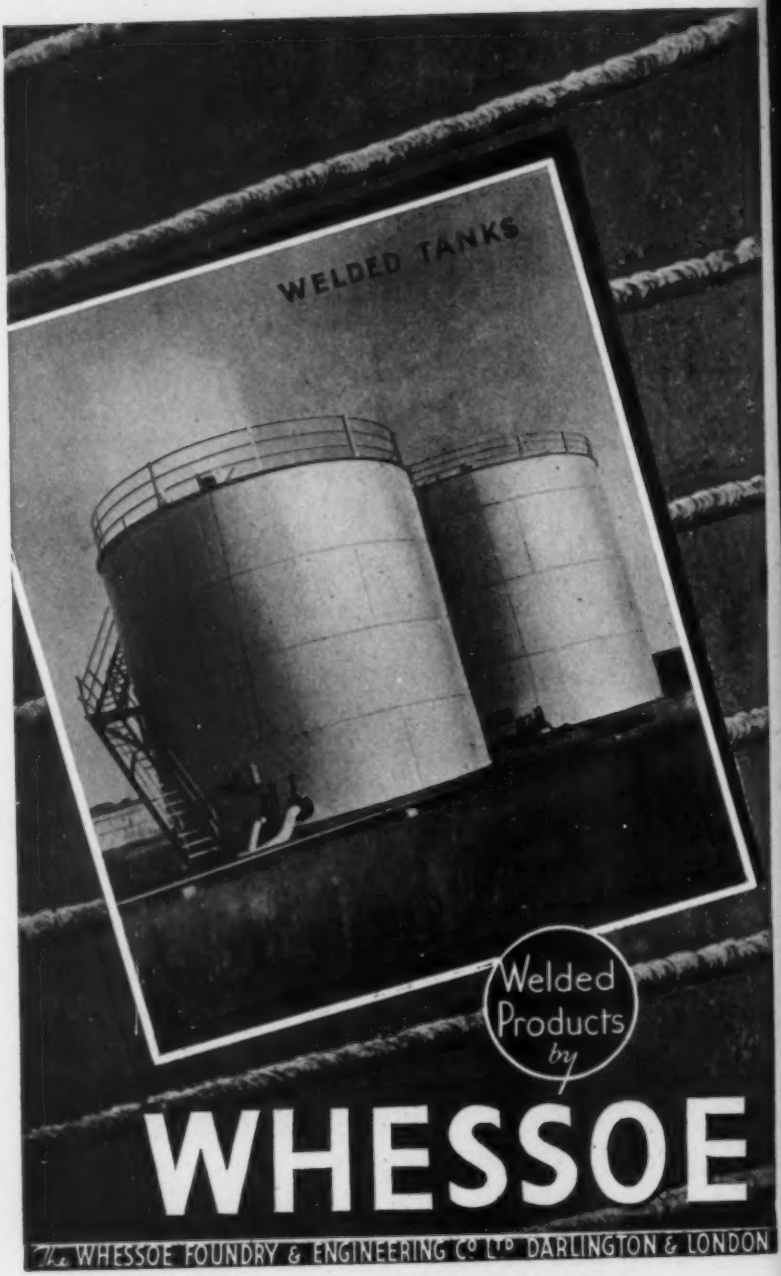

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